BEEF CATTLE PRODUCTION AND MARKETING IN GUANACASTE, COSTA RICA

By

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A DISSERTATION PRESENTED TO THE GRADUATE COUNCIL OF
THE UNIVERSITY OF FLORIDA
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA
1970

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ACKNOWLEDGEMENTS

Special thanks must go to Dr. Raymond E. Crist, chairman of my Supervisory Committee, for his helpful comments and enthusiastic support throughout my research project. I am also grateful for the help given by Dr. Hugh Popenoe. The encouragement and stimulation of my interest in Latin America by the above two men are greatly appreciated, and special thanks go to all other people throughout my university career who did likewise.

The months my wife and I lived in Costa Rica were one of the most rewarding experiences we have had. We are very grateful for the warm remembrances we have of the Costa Rican people. The enthusiastic response and help which Costa Ricans gave made the research a very enjoyable, rewarding experience. It is impossible to give special thanks to them as individuals.

A debt of gratitude goes to the Canada Council whose support made the research possible. Thanks also go to the Center for Tropical Studies, University of Florida, for their contribution to the research expenses. Although the above institutions made the research financially possible, the research and conclusions are the writer's sole responsibility.

Special thanks go to my wife, Carol, as her help and encouragement made the success of this research possible.

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Abstract of Dissertation Presented to the Graduate Council of the
University of Florida in Partial Fulfillment of the Requirements for
the Degree of Doctor of Philosophy

BEEF CATTLE PRODUCTION AND MARKETING IN GUANACASTE, COSTA RICA

By

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June, 1970

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Major Department: Geography

Three methodological approaches analyzed the production function and marketing patterns for beef cattle which have dominated the economy of Guanacaste. Production and marketing were treated as an open system, with research revolving around the effect on, and variability of, each individual component comprising the system and the correlation of the more important components to each other. A cost-benefit analysis was then conducted within the system. As this is a developing region with limited financial resources, conclusions were drawn on whether or not investments pay the returns expected. Special attention was given to the regional variation of each component of the system. Availability and use of resources showed great differences between herd sizes, so size parameters were developed. Four major regions and several subregions, based on differences in physiography, length of dry season, accessibility, herd size distribution, production function of breeding versus fattening ranches, etcetera, were delineated.

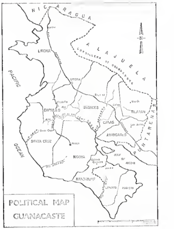
Some resource and management factors were differentiated primarily by region, others primarily by herd size.

Major categories of phenomena for the production function were land use, land values, pasture management, herd management, and herd composition according to breed. Algebraic formulae based on cost were developed for each category. Other statistical methods were used, as for example, a multiple linear regression analysis was done on prediction of land values.

Several specific questions were asked about the marketing system. Are there regional disparities in marketing channels, and are these currently the optimum necessary for economic growth? What types of services exist? What conflict is there between the internal and export market? It was found that the principal variables here were accessibility and distance, climatic differences, and the split in functions between various types of middlemen.

Several conclusions were drawn from the research. The major hindrance to expansion in quantity of animals for most ranches is lack of land followed by constraints imposed by a formidable dry season. Limited here, ranchers are rapidly intensifying their production function by introducing Brahman blood into their herds. Areal specialization results as young animals are sold from breeding ranches located in areas with a long dry season to fattening ranches located in shorter dry season areas. The cost-benefit analyses show that some measures, for example the introduction of new grass species, are not wise investments, while other decisions are economically rational. The marketing services and channels are adequate at the present time, but there are regional disparities. Some channels for the sale of animals conduct animals directly from breeder to market, while others follow a tortuous path comprised of several different types of middlemen. There is a growing conflict between internal and external demands which could disrupt the cattle industry.

On the whole, the industry is economically healthy and does contribute substantially to the economic growth of Guanacaste and Costa Rica.



POLITICAL MAP
GUANACASTE

INTRODUCTION

Relationship to the National Economy

The cattle industry, as a component of the economic and cultural baggage of the Spanish when they arrived in the study area, has had centuries to become firmly established. Spreading nearly to all settled parts of Costa Rica, the demands of the cattle industry have greatly modified the landscape. Few settled areas do not have characteristics attributed to the cattle industry, and in areas where the industry is dominant, cattle originated phenomena are in profusion. An extended history and extensive areal distribution have achieved for the cattle industry an important role in the national economy.

Of the nearly 7.3 million manzanas which constitute the national area of Costa Rica, the 1963 agricultural census states that 1.775 million were utilized for grazing.[1] Extrapolation from this figure indicates that the cattle industry dominates nearly one-quarter of the total land area of Costa Rica. Of land held in fincas of one manzana or more, 45% was utilized for grazing. This compares with 23% for all other forms of cultivation.[2]

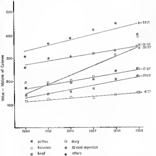
Costa Rica had 64,621 fincas in 1963, with 37,167 or 57.5% having cattle.[3] This is not to say that operators of these fincas are primarily dependent upon cattle production for their livelihood. Undoubtedly, to many of them cattle are of secondary importance in their economic life. Yet when ranch labor and middlemen handling cattle or cattle products are taken into account, a substantial portion of the economically active Costa Rican population is involved and concerned with the cattle industry.[4]

So far, no distinction has been made between the beef and dairy aspects of the cattle industry. In 1963 just over one million head of cattle were in existence in Costa Rica.[5] While a great many animals are held for the dual purpose of producing both beef and milk, slightly under half were classified as primarily beef cattle.[6] Estimates for the production year August 1, 1968 to July 31, 1969 show that 1.417 million head of cattle were in Costa Rica.[7] During this six year period, beef cattle probably became quantitatively more important. While the dairy sector is restricted areally and is in a situation of over-production, the reverse is true of the beef sector.

Production figures clearly establish the cattle industry as vital to the economy of Costa Rica. Agricultural commodities in order of importance of value produced are coffee, bananas, beef products and dairy products. The objectives of the *Plan Operativo Agropecuario para el Año 1969* are the rapid increase in the production of foreign exchange earners and the diversification of the agricultural sector.[8] The efforts of the Costa Rican government in meeting the first objective have succeeded, as indicated by Figure 1.[9] By 1970 bananas should surpass coffee as the prime agricultural commodity; while the beef cattle industry will maintain its position. The efforts of diversification have also been successful in terms of the introduction of new crops, but the absolute value produced has not been as great. As a result, the banana, coffee and cattle industries' share of agricultural

VALUE OF AGRICULTURAL PRODUCTION IN COSTA RICA

Least Squares Analysis of Commodities



Source: Oficina de Planificacion, Plan Operativo Agropecuario, 1968, p. 37

Figure 1

production has increased from 63.3% of the total value in 1964 to 66.7% in 1969.[20]

A major difference is to be found between the two sectors of the cattle industry. While the value of the beef sector increased from 11.9% to 12.5% of total agricultural production, the dairy sector decreased from 9.65% to 8.45%.[11] Beef cattle continues to be the third fastest growing sector in Costa Rica's agricultural situation, but the dairy industry exhibits a very slow rate of growth. Besides differential rates of areal expansion, another factor contributing to these growth rates is the fact that innovations leading to intensive production are just being initiated in to the beef sector, while these have been incorporated within the dairy sector for some time now.

Another reason for this dynamism is the access of the beef cattle industry to a large export market. This was opened in 1954 when Costa Rica started to export frozen boneless beef to markets in the United States. A small but growing market is also found in exporting breeding animals to other Latin American countries as well as some subproducts of the slaughter industry such as hides and animal fats. By 1967 the beef cattle industry ranked third as a foreign exchange earner for Costa Rica, bringing in nearly ten million United States dollars per year.[12] In contrast, exports from the dairy industry earned less than three-quarters of a million dollars.[13] Coffee and bananas in 1967 still accounted for 60% of the total export earnings of 144 million dollars.[14]

Objectives

In the cattle industry, the beef sector was chosen as the topic of study over the dairy sector because it was felt that the beef industry was more dynamic and varied. The beef cattle industry is certainly more significant in terms of value added to the economy and as a foreign exchange earner, both of which are vitally important to a developing nation. Beef cattle have a much wider distribution in Costa Rica. While the dairy industry is located primarily in the upper parts of the Meseta Central, beef cattle are found in all settled parts of the lowlands. See Figure 2. Only four areas of Costa Rica produce cattle as their dominant economic activity. These are the province of Guanacaste, Northern Puntarenas, the San Carlos region and scattered areas of the Valle General in southern Costa Rica. Many other areas also have beef cattle production, but are either too limited in area to show on the map, or are found where other economic endeavors contribute more to the landscape and regional character.

Within Costa Rica only Guanacaste was selected for investigation because this is the heartland of the beef cattle industry.[15] Here, the cattle industry has had a profound influence upon the landscape. Over 50% of the total area is used for grazing at any given time. In addition, cultivated areas are often in rotation with pasture and during the dry season cattle are found in charrales and forests not normally used. Only in very isolated areas are the effects of this extensive grazing not to be seen. The result is that two-thirds of Costa Rica's beef cattle are found in Guanacaste.[16]

This research has been organized and carried out to meet one basic objective, to analyze and interpret the various components of the beef cattle industry to such an extent that recommendations for economic development can be made at the firm and industry levels.

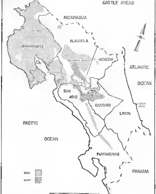

COSTA RICA
CATTLE AREAS
NICARAGUA
ALAJUELA
GUANACASTE
HEREDIA
ATLANTIC
OCEAN
SAN
JOSE
CARTAGO
LIMON
PACIFIC
OCEAN
PUNTARENAS
PANAMA
N
PUERTO LIMON
SAN JOSE
BEEF
DAIRY

Figure 2

This objective can be divided into two major components according to a functional division. The first is the actual production of beef cattle, the second is the marketing system which influences this production.

An analysis is made of the process of cattle production at the firm level in terms of the utilization of the various resources at the rancher's disposal. Variations in the physical environment and herd composition determine the ultimate limits of production. However, the differences in managerial skills and the ranchers' perception as to how he can use resources account for much of the variation in the production function. At the same time, there are trends at the industry level which need to be analyzed, not so much in terms of their beneficial or detrimental effects, but in terms of their degree of impact. It must also be recognized that the beef production system is only one part of the economy; as an open system it can be highly influenced by fluctuations in the total economic picture of Costa Rica.

The question here is to what extent the rancher is a rational, economic man as opposed to a satisficer.[17] Thus the various processes in beef cattle production are subjected to a cost-benefit analysis. The optimum levels of production under existing conditions can then be determined as opposed to what is being accomplished at the present time.

Delimitation of subregions based upon factors of production is essential if development programs are to achieve their objectives. This was to determine the industry's strengths and weaknesses according to area. With this knowledge, innovations could be introduced or resources allocated within the beef cattle industry to create a more rational economic structure. Greatest gains in development come in those areas which have the best resource structure. At the same time, areas of weakness should be given special attention to assure that regional balance is maintained within Guanacaste.[18]

The second component of the objective is concerned with the determination of the suitability and availability of the marketing infrastructure providing the links between the ranch firm and the outside. Seen in the sense that the marketing system carries both production out and needed resources in, it then becomes a vital part of the cattle industry. In terms of economic development "changes in the organization of marketing might be necessary if changes in production were to be realized in an underdeveloped area, and that marketing might be the leading factor in encouraging change in the production sector."[19] It then becomes a function of this research to provide a case study illustrating the role marketing plays in the growth and development of the Guanacaste region.

At the initiation of the research several hypotheses were put forth to be tested. Because Guanacaste has a long history of settlement based on cattle production the marketing system would be well-developed, fine tuned, and variations in production and situation should have corresponding changes in the marketing services and channels. The marketing system would be molded by strong attempts to overcome the dry season in Guanacaste. The fact that Guanacaste is a highly diverse region physically, as might be anticipated because of its size, adds greatly to the complexity of the marketing systems there.

The factors of accessibility and distance would play an important part in the market system. It was theorized that there would be a decrease in services carried by the system as distance became greater from and accessibility less to major assembly points such as Liberia, Nicoya and Cañas. Linkages between ranch and market could be expected to become more and more tenuous and complex with distance from these towns. Using channels and links, areas could be placed on a scale measuring difficultness of the marketing process for the ranches. Some areas would have a full range of marketing services, others would be virtually marketless. Marketing areas might therefore be subject to central place analysis.

An imbalance would probably exist in all marketing regions between what has developed and the optimum necessary for maximum growth of the cattle industry. Research was expected to show that was true even in those regions which had a full range of existing services. An analysis of the marketing regions would hopefully lead to suggestions about development of the marketing infrastructure. This would be in the form of introducing new services, changing the emphasis of old ones, and developing new institutions and channels through which the ranch firm and the outside world would be more rationally linked.

Methodology

Two concepts have come to play an important role in the methodology of geography. The Ad Hoc Committee on Geography published *The Science of Geography* in 1965 which established the importance of spatial analysis in geography.[20] As an example, in 1968 B.J.L. Berry and D.F. Marble wrote a reader called *Spatial Analysis* in which concepts such as directional orientation, distance, and relative position were emphasized.[21] The second concept is the analysis of systems, or the study of a complex whole rather than the parts which make up that whole. For example, A Systems Analytic Approach to Economic Geography by R. McDaniel and M.E.E. Hurst, published in 1968, is a call to use this concept much more in the field of geography.[22]

Both of the above concepts can be applied to the analysis of the beef industry in Guanacaste.[23] An open system requires a constant flow of energy to maintain and preserve itself. The biotic nature of the growth cycle for pasture and animal reproduction is one example of energy expended. The efforts to overcome and modify such physical processes is another, with Guanacaste having the special problems inherent in combatting the dry season. The outflow of produce is a negative flow of energy while the inflow of profits, credit, information, etcetera, would be positive flows.

The balances of energy would vary from area to area due to variations in the resource base and to friction caused by inertia, distance, and accessibility on the various flows of energy. For example, an area far from main communication routes would have far more difficulty establishing in and out flows of material than an area well endowed with communications. The result of this is the emergence of a wide variety of spatial patterns. Guanacaste, being large and diverse in a number of variables, exhibits spatial patterns of great complexity.

These spatial patterns are first analyzed as the distribution of phenomena, then in terms of the interaction of factors which cause the locational characteristics of the phenomena in question. Systems analysis is concerned with the maintenance of a 'steady state' with regard to energy inflow and outflow. The creation of, and adjustments required to maintain, this equilibrium can in most cases be equated to the interaction of phenomena as dealt with in a spatial analysis. Changes in the demand for product would surely be countered by changes in the supply and vice versa. That this would tend to further complicate the spatial patterns is entirely possible, as one area may adjust upward while another adjusts downward, or different combinations of resources can be initiated in different areas to meet the same objective. The main emphasis of both spatial and system analysis is the interconnectivity of the various phenomena which form part of the whole, in this case the cattle industry of the province of Guanacaste.

Both concepts are very much concerned with the time element. Characteristics of the open system are the striving toward optimum magnitudes while at the same time maintaining the organizational forms which are a basic part of the system. Spatial patterns may also change as these adjustments are made and new connections are formed, or existing connections modified. If the overriding objective be economic development and growth in Guanacaste, then both the organization and form of the present cattle industry system may have to be modified, or maybe even eliminated altogether and replaced by new systems. While the production function for beef cattle is within physical and biotic parameters difficult to change, the marketing aspects of the cattle industry can be changed drastically over a short period of time. However, it must be stressed that powerful cultural characteristics such as prestige of land holding and factors of cultural lag will also play a profound role in maintaining or modifying existing systems.

Analysis of the system and spatial patterns should be able to demonstrate problems which exist throughout the industry. The last step of a spatial analysis should be concerned with generalizing solutions to problems, putting forth suggestions which would lead to the economic development of the study areas. As the industry develops and problems which hinder productivity are overcome, the economic rational producer will be more and more in evidence or at least the satisficer will have a broader knowledge of his possibilities. More uniformity in basic production units such as breeding stock and pastures, coupled with similar managerial skills, would lead to the same combinations of resources and a homogenization of firms within the industry. The condition that different initial conditions may lead to similar end results, a characteristic of a system, would tend to be met.

Actual field work in Costa Rica commenced with a gathering of statistics dealing with the beef cattle industry. While this material was gathered from many governmental and nongovernmental agencies, four sources were especially extensive. The personnel of the Ministerio de Agricultura y Ganadería (MAG) were knowledgeable about the general situation of the cattle industry. Their investigations culminated in an unpublished manuscript entitled *Situación Actual Del Ganado de Carne, Pastos y Forrajes en Costa Rica* written in 1969.[24] The Oficina de Planificación also had a strong interest in cattle. In 1965, this office, coupled with Banco Central de Costa Rica, published the *Plan para Fomento de Ganadería de Carne*.[25] The cattle industry has also figured prominently in each of their annual plans. The Consejo

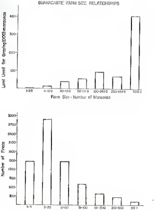
Nacional de Producción (CNP), which has the responsibility for fixing the export quota each year, has a large amount of material dealing with this aspect of the industry. The Dirección General de Estadística y Censos has information dealing especially with consumption and demand. These last two sources made uncompiled statistics available for the last cattle year, 1968-1969.

Information of a nonstatistical nature is much more difficult to come by. Studies for Central America are becoming more numerous, as for example *Bases Para el Desarrollo de la Ganadería Bovina de Carne en Centroamérica y Panamá* and *Mercados del Ganado y la Carne en el Istmo Centroamericano*, both published by Servicio Técnico Interamericano de Cooperación Agrícola (SIECA) in 1968.[26] One study dealing with land utilization and potentialities within the study area was especially beneficial. This is *Planificación del Uso de la Tierra, Península de Nicoya* by J.J. Castro.[27] The Asociación Regional para el Desarrollo de la Península de Nicoya has been responsible for a number of studies, but unfortunately none has dealt specifically with the cattle industry. Outside of the Nicoya Peninsula, material becomes very scarce.

Two studies dealing specifically with the cattle industry are available. Alfaro's study entitled *Perdidas de Peso en el Transporte y en Destace de Ganado de Carne* is useful in determining historical transportation and slaughter rates while J. O. Jara's study *Algunos Aspectos de la Comercialización del Ganado y la Carne de Res en Costa Rica* gives a good insight into certain aspects of the marketing situation.[28] No study matches the scope which this study has undertaken; a situation which would have been useful in a comparative sense.

Using knowledge gained from an extensive reconnaissance some of the problems in selecting a sample of ranches were recognized. It was felt that a sample could be drawn using three basic criteria. First, all types of physical variation needed to be included. Second, the factor of distance and accessibility was very important, especially with regard to marketing. All points near and far from principle assembly points or towns had to be considered. The size of farm was felt to be the third important criterion. The resources available at farm level, resources introduced from outside, and managerial ability change greatly from one ranch size to another. Figure 3 shows that the large ranch, over 500 manzanas, is by far the most important in beef cattle production. Any change here would effect the entire beef cattle industry. But Figure 3 also shows that the other size categories are well represented in terms of total participation. Therefore samples were drawn from all size categories, using the same proportions as found in the 1963 census. Using the first two criteria in combination, Guanacaste was subdivided into fifty areas from which one ranch was drawn as a sample.

Before final selection of the ranch was made for each area, another intensive reconnaissance was carried out. Various people, from agricultural extension agents, to ranchers, to the 'man in the street', were talked to in order to gain as thorough a knowledge as possible of that area's characteristics. Special problems as well as averages were collected wherever possible.



GUANACASTE FARM SIZE RELATIONSHIPS

Source: Dirección General de Estadística y Censos, Censo Agropecuario, 1963, pp. 36-37, 216

Figure 3

The formal sample obtained most of the information needed, but two further steps still had to be taken in interviewing ranchers. Cost data was very difficult to come by, therefore an additional number of ranchers who kept some sort of records were interviewed to obtain this material. Similarly, additional information on specific aspects of the cattle industry was required. Again this meant going to those ranchers where this material was available. Second, the formal sample tended to exclude the small rancher. Additional interviews outside the sample were directed toward obtaining material from the small rancher. These interviews were spread throughout Guanacaste, using the same criteria established for the formal sample.

Information on individual ranchers was obtained by means of a questionnaire which took from one to four hours to conduct. The questionnaire was divided into six parts of unequal proportion. The first part dealt with land utilization and range management practices. The second section dealt with composition and maintenance of the beef cattle themselves. Within these two sections many questions dealing with energy inflows carried by the market were analysed in terms of their effect on the production function. The next three sections dealt with outflows from the ranch carried by the market infrastructure. In many cases, what is an outflow for one rancher is an inflow for another, as for example the sale of young stock for fattening. These three sections dealt with the market for exportation, the market for internal consumption, and the market for breeding animals. Finally there was a miscellaneous section for factors which could not easily be fitted into the foregoing sections. Examples here were the length of occupancy upon the ranch, land registration, and general questions on how the rancher perceived the beef cattle industry in a regional context.

Once the ranchers' situation with regard to production and market was known, other types of research were carried out in order to more fully understand the marketing aspects. A questionnaire was devised for the middlemen involved in buying and selling animals. Questions here determined the trading area of the individual, services which he might or might not carry to the rancher, etcetera. Another questionnaire was made to interview the local retail merchant in the various towns of Guanacaste. While in many cases similar to that used for the middlemen, this questionnaire emphasized the contact with the consumer. Inspection of local slaughter plants was closely connected to this phase of the research. Truck drivers were interviewed to determine the problems involved in transporting beef animals. Special attention was also paid to the various export firms and the export situation in general. For all the above, cost and profit data was collected wherever possible.

Material was gathered in such a way that the interrelationships between the various factors involved were emphasized. The time element was also emphasized in order that various trends and predictions about the beef cattle industry might be made. Spatial patterns were developed. In some cases, additional observations and traverses had to be conducted to delineate the parameters of specific phenomena or group of phenomena. A further reconnaissance to determine the effects of the dry season in Guanacaste upon various aspects of the production function was needed.

Chapter II deals with the production function of the individual ranchers. Divisions based on final output, size, and area were developed. Mathematical models were computed for each of the size divisions, incorporating every factor in the production function.[29] For variation imposed by area or final output, the reader has the necessary information to develop or modify the existing formulas. As the formulas are based on a cost analysis, an individual rancher for example could use the formulas to determine his own cost structure.

Chapter III deals with the various marketing aspects of the system, with emphasis on the proving, modification or disproving of the hypotheses advanced. Chapter IV gives conclusions, with recommendations arrived at vis-à-vis the beef cattle industry.

NOTES

1. Dirección General de Estadística y Censos, *Censo Agropecuario, 1963*, Dirección General de Estadística y Censos, San José, 1965, pp. 32-33.

2. Ibid., pp. 32-33.

3. Ibid., p. 212.

4. The working force in Costa Rica was 64.5% involved in agriculture in 1953, 57.2% in 1962 and 49.5% in 1969. The first two figures derived from Garden, J.S., "Labor Mobility and Economic Growth: The Central American Experience - Costa Rica and El Salvador," *Economic Development and Cultural Change*, Vol. 17, 1969, p. 324. The figure for 1969 was obtained from the Ministerio de Planificacion.

5. Dirección General de Estadística y Censos, *Censo Agropecuario, 1963*, p. 212.

6. Ibid., p. 221.

7. Unpublished figures from the Consejo Nacional de Producción, Departamento de Investigaciones Económicas y Planificación.

8. Oficina de Planificación, *Plan Operativo Agropecuario para el Año 1969*, Oficina de Planificación, 1968, pp. 31-32. Other objectives are also listed.

9. The next ten important agricultural commodities are: caña, arroz, maíz, frijoles, huevos, cacao, ganado porcino, algodón, cerga, tabaco. Figures for 1968 are estimates, for 1969 projections.

10 Oficina de Planificación, *Plan Operativo*, 1968, p. 37.

11. Ibid., p. 27.

12. Dirección General de Estadística y Censos, *Comercio Exterior de Costa Rica, 1967*, Dirección General de Estadística y Censos, Sección de Publicaciones, San José, Costa Rica, 1968, p. 341.

13. Ibid., p. 343.

14. Ibid., pp. XIX, XXIV, XXV.

15. In 1963, Guanacaste had 380,144 cattle. The next province in importance is Alajuela with 235,803, but part of this province lies within the dairy zones. Dirección General de Estadística y Censos, *Censo Agropecuario, 1963*, p. 214.

16. Ibid., p. 213.

17. See Simon, H.A., "A Behavioral Model of Rational Choice," *Quarterly Journal of Economics*, Vol. 69, 1952, pp. 99-118.

18. It must be left to the Costa Rican planners as to whether they will develop Guanacaste as a whole, or concentrate only on special areas within the region.

19. Abbott, J.C., "The Development of Marketing Institutions," in Southworth, H.M. and Johnston, B.F., *Agricultural Development and Economic Growth*, Cornell University Press, Ithaca, 1967, p. 365.

20. Ad Hoc Committee on Geography, *The Science of Geography*, National Academy of Sciences - National Research Council, 1965, pp. 44-53.

21. Berry, B.J.L. and Marble, D.F., *Spatial Analysis, A Reader in Statistical Geography*, Prentice-Hall, Englewood Cliffs, 1968.

22. McDaniel, R. and Hurst, M.E.E., *A Systems Analytic Approach to Economic Geography*, Association of American Geographers, Washington, 1968.

23. The following discussion is based on the characteristics of a spatial pattern as listed by the Ad Hoc Committee on Geography, *The Science of Geography*, 1965, and on the characteristics of an open system as given by Chorley, R.J., *Geomorphology and General Systems Theory*, United States Geological Survey, Professional Paper, 1962, pp. 3-8.

24. Ministerio de Agricultura y Ganadería, *Situación Actual del Ganado de Carne, Pastos, y Forrajes en Costa Rica*, Unpublished paper, 1969.

25. Oficina de Planificación, *Plan para Fomento de Ganadería de Carne*, Oficina de Planificación, San José, 1965.

26. Garcia, M., *Bases Para el Desarrollo de la Ganadería Bovina de Carne en Centroamérica y Panamá* and Navarrete, M., *Mercadeo del Ganado y la Carne en el Istmo Centroamericano*, both published by SIECA, Guatemala, 1968.

27. Castro, J.J., *Planificación del Uso de la Tierra, Península de Nicoya, Costa Rica*, Instituto Interamericano de Ciencias Agrícolas de la OEA, Turrialba, 1968.

28. Alfaro, G., *Perdidas de Peso en el Transporte y en Destace de Ganado de Carne*, STICA, San José, 1955; Jara, J.O., *Algunos Aspectos de la Comercialización del Ganado y la Carne de Res en Costa Rica*, Instituto Interamericano de Ciencias Agrícolas, Turrialba, 1967.

29. In the system of cattle production and marketing, even one year of research would not bring out and give proper importance to all variables involved. However, the author hopes that at least the major factors have been accounted for.

THE PRODUCTION FUNCTION

Classification

In order to understand and develop the spatial characteristics of the beef cattle industry, the components of the production and marketing system were evaluated in terms of their accessibility, incorporation, and profitability to the individual economically active in this industry. This chapter focuses upon the production function of beef cattle with the energies expended on production being measured in terms of input. The two basic inputs are land and cattle. The variations in quantity and quality, coupled with extraneous factors which impinge upon them, lead to a complex combination.

The simplification of the analytical problem starts with the grouping of ranches into four size categories based upon the amount of cattle found during the wet season. The parameters are: (1) Size A - under 20 head; (2) Size B - 20-100 head; (3) Size C - 100-500 head; and (4) Size D - over 500 head.[1] Each of these groups can be distinguished according to differences in the organization of their resources, and, indeed, the use or non-use of resources. Markedly different production functions can be recognized, with resultant differences in the groups' input-output structures. It must be noted here that the parameters are somewhat arbitrary; both groups and individual components will certainly overlap in certain aspects at least.

Summary models will be built for each group based on 10, 50, 300 and 1,000 head respectively. Variations from the norm will be explained in the text in such a fashion that the reader will be able to construct a model to meet specific variations.

The second division which needs to be made is one based on the final output of the various ranches. Three categories can be developed. See Figure 4. Output I consists of young calves which are sold at a relatively young age. Output II is the value added to the above mentioned animals by facilitating their growth to slaughterable weight. Many ranchers (criadores) produce only Output I, others (engordadores) concern themselves only with the growth processes of Output II. Often, ranchers will control the product from conception to slaughter (Outputs I and II) or will retain engordadero functions for only part of the fattening cycle of the animal. On these ranches the production functions are usually separated within the individual firm as much as possible for the two outputs. A small minority of ranches concentrate on Output III, or the production of animals destined to become involved in the reproductive cycle. All criadores have a non-output or feedback situation where they replace breeding stock from their own herd. But Output III is distinguished in that the animals derive from purebred seed stock. Purebred herds are owned for the express purpose of selling high quality stock to other ranchers in order to upgrade criollo breeding herds.

Regionalization of Guanacaste can be made using differences in the physical environment, isolation factors, and the differentiation in the distribution of the above two criteria for classification. See Figure 5.[2] These general divisions are to be thought of as a means of

CLASSIFICATION by OUTPUT

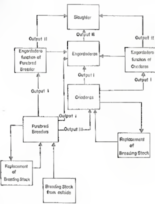

Slaughter
Output II
Output II
Output II
Engordadero function of Purebred Breeder
Engordaderos
Engordadero function of Criadores
Output I
Output I
Criadores
Output I
Output I
Purebred Breeders
Output III
Replacement of Breeding Stock
Replacement of Breeding Stock
Breeding Stock from outside

Figure 4

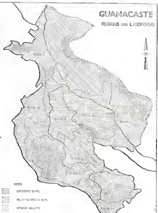

GUANACASTE
REGIONS AND LANDFORMS
N
REGION 3
REGION 2B
REGION 1A
REGION 2C
INDEX
EXCESSIVE SLOPE
HILLS – SLOPES TO 30%
INTERIOR VALLEYS
PLAINS SLOPES TO 10%
BAJURAS

Figure 5

facilitating locational description as well as an attempt to delineate definitive subregions of productivity. The lack of information about the physical environment as well as the crudeness of the economic system (which obscures fine tuned responses which cause many areal differentiations) prohibits this. For recommendations concerning small specific areas, mapping such as that done by Castro in Nicoya is essential, and needs to be done for the rest of Guanacaste.

The major criteria for division are listed below, with a more detailed analysis being incorporated into the discussion on individual phenomena.

Region I

-Generally flat and fertile clay or clay-loam soils suitable to machine cultivation.

-Good transportation network with easy accessibility to the input and output market infrastructure.

A.
-Very large ranches dominate.

-Most purebred breeding ranches found here, but area dominated by criadores.

-Some cultivation of cotton and rice.

B.
-Some of the best soils and levelest land found here.

-Ranches smaller than in IA, but all sizes are well represented.

-All three outputs located in this area.

-Economy more diversified, with extensive cotton cultivation, some sugar.

C.
-Flat coastal plain hemmed in by hills and the Gulf of Nicoya.

-Transportation network less well developed than in other areas of Region I.

Region I (continued)

C. (continued)
- Farm size groups B and C dominate.

- Criadores dominant.

Region II

- Land often rolling to rugged with lateritic soils, these interspersed with fertile valleys, plateau areas.

- All ranch sizes well represented.

- Criadores dominant, interspersed with engordadores.

- Commercial cultivation minimal, subsistence cultivation widespread.

A.
- Accessibility degenerates southward.

- Size groups B and C dominate, other sizes found as well.

- Main areas of commercial cultivation, being tied to valleys and plateaus

B.
- Small pockets along coast with good, level land, otherwise very rough land with poor, thin lateritic soils.

- In places, dry season less severe than in other parts of the Nicoya Peninsula.

- Accessibility poor to practically non-existent.

- Ranch size groups A and B dominate, some C and D in pockets.

C.
- Some areas extremely rough, but pockets of level, alluvial soils derived from surrounding hills.

- Accessibility practically non-existent, except for small areas in the south

- Ranch size A and B dominant, a very few size C present.

Region III

- Dominated by rough, rocky land with infertile thin soils.

Region III (continued)

- Accessibility good due to Pan-American highway, but no feeder roads.
- Ranches fairly large due to low carrying capacity of land, but area incorporates large numbers of Size A as well.
- Criadores dominate, with engordadores in high mountain areas where dry season shorter.
- Primarily subsistence cultivation.

Region IV

- Flat to rolling land, able to support some intensive cultivation, upland rugged areas next to cordillera.
- Dry season shorter than in other parts of Guanacaste.
- Good accessibility due to Pan-American highway and some feeder roads, closest to the major markets of the Meseta Central.
- All ranch sizes represented, especially Size C, with Size A and B in the upland areas.

Land Use

To appreciate the importance of the cattle industry to the economy of Guanacaste, the land use situation in general needs to be understood. Of greater interest, however, is the land use situation of the individual rancher, especially what influences the present land use makeup and how it is changing. Using the classification developed and mapped by Castro, only 6% of the total land area of the Nicoya Peninsula is recommended as suitable for intensive cultivation.[3] These are found in Region II primarily where deep alluvial soils with good texture and drainage are concentrated. Thirty-eight percent of Nicoya is suitable for extensive cultivation, being located primarily in valleys scattered throughout the peninsula.[4] In other areas of Guanacaste, Plath recommended that areas of fluvial-lacustrine soils along the Rio Tempisque and along the coast would be suitable for intensive cultivation or pasture if they were not made useless due to ocean salinization.[5] The plateau and valley area north and west of Tilaran would also fit into his intensive use category. Most of the ash-derived soils of Region IA and Region IV, south of the Pan-American highway generally, would fall into Plath's intensive pasture category or into forestry.

Areas suitable for forestry cover 54.9% of the Nicoya Peninsula.[6] Region IIB is thoroughly dominated by this land use existing on very rough and rolling land with thin lateritic soils. Recognizing a *facto compli* that settlement is widespread, Castro recommends that this area could be used for very extensive grazing if the soil cover was kept intact. Plath recommends that similar areas which should remain in forestry are to be found along the Guanacaste Cordillera in Region III and IV. He also recommends that most of Region III be reserved for extensive grazing as this area is extremely rocky with very thin soils.

Castro designated 1.5% for very extensive land use, primarily around the Rió Tempisque where the land is being inundated repeatedly and soils are very saline.[7]

The land use of the individual ranch firm shows variation according to size, function, and area. Six major categories of land use were determined for each ranch. These are: Lc - commercial crop land; Lm - foodcrops; Ls - feedcrops, Lp - pasture; Lb - bajuras or sitios, and Lf - forest. These are discussed in detail below.

TABLE I

GUANACASTE LAND UTILIZATION ACCORDING TO RANCH SIZE
(In percent)

Size	Land Use Categories					
	Lc	Lm	Lr	Lp	Lh	Lf
A	6	10	---	45	---	39.0
B	---	5	---	72	7	16
C	7	2	0.5	65.5	4.3	20.7
D	2.2	0.5	0.1	37.0	30.4	29.8

Commercial Crop Land (Lc)

This land is for the most part used for cotton. Major cotton areas are found in Region IB, where certain ranches are dominated areally by this crop. Cotton is also grown along the Pan-American highway in Region IA. One cane growing area is well developed on the lower Tempisque in Region IB, and this crop is currently being introduced into the coastal areas of Region IV. Rice production is the newest commercial crop to be introduced on a large scale. Ranches on the Tempisque floodplain in Region IA and on the former Lake Arenal near Tilarán account for most of the commercial output.[8] Size D ranches have most of this production but have a low percentage because the large ranches of Region IA have little or no commercial production. Most Size B and C ranches concentrate their entire resources upon cattle production, the 7% indicates a few relatively large ranches in Region IB where cotton dominates the cattle activity or where ranchers rent their cultivable areas to cotton farmers. On Size A ranches, food crops such as upland rice and corn are grown for sale. Since their herd size often is insufficient to fully utilize their land holdings and family labor, ample opportunity is provided to raise food crops to earn extra cash. Even though it was not encountered in the formal sample, many small Size B ranches also follow this pattern.

Food Crops (La)

The percentage of land under food crops is understandably higher for the small rancher as in many cases he exists near subsistence levels, with food crops being his major concern.[9] For the man who has only one or two head of cattle, subsistence crop areas could very well be the dominant land use. In a minifundia situation land pressure may be very great and the rancher cannot afford to devote more than a small portion of his land to cattle production. The majority of large ranches permit their workers to raise subsistence crops on ranch property, but even this amounts to no more than 200 manzanas on the very large ranches. A very wide range of crops is grown, with a concentration on corn, rice, bananas, beans, and squashes.

Feed Crops (Ls)

Feed crops are grown in an attempt to combat the detrimental effects of the dry season. The crop grown is sorghum and is used as supplemental feed during the period January to May. Sorghum is grown under mechanized cultivation by large ranchers. Its utilization under other forms of cultivation was not found on small ranches.

Forest (Lf)

Forestland forms a large part of the total land area of all ranch size groups, but for different reasons.[10] The large ranches, especially in Region IA, have consolidated large land holdings but have only recently initiated large scale development. Thus, only good land adjacent to the Pan-American highway or around the ranch stead was put into pastureland and poorer land or land distant from transportation was held in reserve. During the dry season forest areas would be utilized for extensive grazing to obtain at least some nourishment. With the introduction of agrarian reform and the export market, the concept of idle land changed. Now these large ranches have scheduled clearing programs ranging to 200 manzanas per year, with pasture expanding onto marginal land. For example, the thin rocky soils of Region III and the hill lands of Regions II and IV are being converted to pasture.

The medium sized ranches, B and C, have already expanded their production system to capacity. Cattle raising has become the major economic concern of these ranches, and a shortage of land is a major block to increased production. Most ranchers in Regions IV, IB, IC, and IIA have essentially developed land fully for pasture. Exceptions are the forested areas found along watercourses and in rough, badly eroded land. These scattered enclaves of forestland are also used for grazing in the dry season. Along the watercourses, feed is often scarce as cattle tend to overgraze areas near their watering places. The relatively high percentage (16 and 20.7) of forestland is due to the inclusion of several recently established ranches. In the areas of expansion along the cordillera of Guanacaste and the hill lands of Nicoya insufficient time has elapsed since settlement to establish pastures, even though an active program of land clearing is in progress.

In ranch size A, two main reasons account for the high percentage (39.5) of land in forest. These small ranchers are associated with very poor land, of either rocky or excessive slope, where forest cover is the only vegetation cover which is not eroded away. Second, these small ranchers find it extremely difficult to increase their herd size. Any disaster to their economic situation results in the premature selling of their breeding stock or their commercial animals. That they can sell animals to survive is one of the main reasons why they desire cattle ownership. Hopes that a newly established pasture can be utilized are dashed when a member of the family becomes ill and needs medication or when a poor crop necessitates buying food. In such cases newly established pasture reverts to forest, often without being utilized at all. Only in the very small farms where the family would almost starve rather than sell their one or two milk cows is this situation not true. People who have just shifted from Size A to B seem to be able to increase their herd size quite rapidly as they have sufficient production to sell for emergencies, to absorb normal operating costs or profits, and still expand breeding stock numbers.

Ranchers who participate only in the fattening process (Output II) have already extended their pasture acreage as much as they are willing. While there still is some forest on engordadora ranches, ranch owners feel that additional expansion of pasture onto these areas is either uneconomical or they want these areas for shade, or to stop erosion (along riverbanks primarily), or for aesthetic values. Thus only the breeding ranches participate in any significant pasture establishment.

Shade trees to enable cattle to conserve body moisture are provided by the majority of ranches in scattered areas throughout the ranch. This in turn reduces weight loss. In Region IV and parts of Region II living fences are also very much in evidence. A low angle view of intensively used pastureland does give the impression of forestland in these areas.

Bajuras and Sitios (1b)

The acquisition of a bajura probably ranks first in the order of ranching priorities. The characteristic of a bajura which is important to the rancher is the poorly drained nature of the land which causes vegetation to remain green for at least part of the dry season. Vegetation is scrub, forest or grass, all of which have a low carrying capacity, but bajuras can be improved by introducing new grass species. These bajuras are heavily grazed during the dry season, allowing the cattle either to maintain their weight or to lose it more slowly than those animals which exist on dried up pasture areas.

This means a quicker turnover of animals in the production cycle with consequent higher profits for the rancher. Bajuras are very much in demand among the engordaderes where weight gains or losses are equated with profits and losses. Criadores will accept weight losses of breeding stock as long as calves are still produced. Thus a linear distribution of engordaderes is found along the coasts of the Nicoya Peninsula, concentrated on poorly drained coastal plain areas and river deltas. Smaller scale engordaderos also are found on tiny floodplains in the interior parts of the Nicoya Peninsula. Along the Rió Tempisque and on the eastern side of the Gulf of Nicoya where the most extensive bajuras are developed, large ranchos incorporating both criador and engordadero functions dominate. In Region IV, where the rainfall is more plentiful and the dry season shorter, the emphasis on bajuras is much less.

Sitios, on the other hand, are low capacity grass areas which have not been modified by man. They are found on extremely thin, poor soils which will not support a forest cover, or at very high altitudes, as, for example, on the tops of some of the hills in the cordillera of Guanacaste. They exist throughout Guanacaste and in general are not valued much above forest land.

Pasture (Lp)

Because pasture plays such an important role in the cattle industry, a separate section will deal with this subject later.

Land Value

In any agricultural production, one of the major cost inputs is the actual land area required. This is especially true of beef cattle, as they constitute an extensive land use industry. The actual capital requirements necessary to buy a ranch for initial production therefore become one of the prime factors necessary to judge economic rationality.

It is almost impossible to obtain information about capital requirements. Most of the ranches in Guanacaste have had fairly stable ownership patterns. It is very common to find title to land passing from father to son without much consideration of what the land itself is actually worth. The southern Nicoya Peninsula and the upper regions of the cordillera of Guanacaste have been settled by homesteaders in relatively recent times, and this too is not conducive to an accurate knowledge of present land values. One of the greatest discrepancies in response to questions on land values was between value per manzana and value for the total farm, the latter invariably being lower.

However, land holding changes and land holding negotiations have been numerous enough so that some idea of the value of land inputs can be obtained. As in other investments, the final price the buyer is willing to pay rests upon what he thinks he will be able to realize on his investment. Figure 6, showing land values for Guanacaste, is not accurate in detail. It should not be taken as an indication of the value of individual ranches, as there is a great deal of local variation. Trends are quite clearly shown however. Values range to over 1,000 colones (₡1,000) for land which has all the advantages for production to under ₡200 for land which has all the disadvantages.[11] Advantage or disadvantage for any piece of land is based on six factors: length of dry season, land capacity as influenced by physiography, accessibility, actual land use, existing capital investment, and ranch size. One other factor which needs to be taken into account is the prestige or social status which adheres to land ownership, but this is a constant and does not lead to value variation.

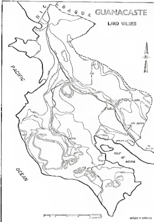

NICARAGUA
GUANACASTE
LAND VALUES
N
PACIFIC
OCEAN
LAS JUNTAS
GULF OF NICOYA
To San José
values in colones

Figure 6

The great desire for land does make the land market a sellers market, with land values in general being above those actual profits would seem to warrant.

Dry Season

The whole of Guanacaste is subjected to a wet-dry climatic regime which has a profound influence upon the production function of beef cattle.[12] During the dry season pasture lands dry up and enter a period of dormancy. Besides considerable weight loss, the mortality rate for old or infirm animals increases, and the fertility of breeding animals declines. With the advent of the wet season, pastures turn green and lush and the above trends are reversed: cattle gain weight, mortality drops and fertility increases.

During the wet season, pastures are often under-grazed, as the actual number of cattle per manzana is determined by the carrying capacity of the same pasture during the dry season. This is only one-third to one-half what it is during the rainy season. In most areas of Guanacaste, the carrying capacity is maintained around one animal per manzana, although there is great variety depending upon the area and type of pasture. Thus, in most parts of Guanacaste it is not physiographic or soil factors which determine upper limits of productivity, but the length and severity of the dry season. As cattle production is a biological function and cannot change swiftly to meet a mild dry season, overall production is geared toward the most severe dry season conditions. However, the engordadores producing Output II can alter their production schedules week by week, and with a mild short dry season can increase their ranch productivity by buying more animals if they are available. This is one of the major advantages they have over the criadores, the ability to respond swiftly to favorable climatic conditions.

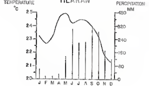
The main depressant on land values in Guanacaste is the dry season; land is considerably cheaper than in other settled parts of Costa Rica with a more equitable precipitation distribution. Within Guanacaste there are regional variations in the dry season, ranging from four to six months in duration. See Figure 7.[13] The chart for Liberia is fairly representative and shows that the dry season does fall during the low sun period. One significant factor is the rather abrupt transition from wet to dry and from dry to wet. Average temporal parameters are from mid-December to sometime in May for the dry season, but this varies greatly from year to year. Note the almost complete absence of rainfall during several months: there is no respite.

The areas with a shorter dry season, represented by the climatic regime of Tilaran, are quite limited in extent. These areas are generally cooler as well, which decreases loss of moisture due to evapotranspiration. Along upper, western parts of the cordillera of Guanacaste, the trade winds coming from the east sometimes spill over and deposit their rainfall. Unfortunately most of these areas are very poor in terms of physiographic and accessibility aspects. Only around Tilaran in Region IV does a short dry season combine favorably with these other factors. The coastal plain of Region IV in Guanacaste and the southern Nicoya Peninsula also have shorter dry seasons.

The value of a shorter dry season to ranchers will be analysed later but one indication can be given here. The same quality pastureland in physiographic and accessibility factors will rent for five colones

CLIMATIC CHART

TILARAN



LIBERIA

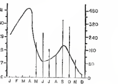


Figure 7

per head per month around Nicoya and Liberia, but will rent for seven colones around Tilarán. This increase is due partly to a better climate, but also to an increased demand. Engordaderos will often buy more animals than their own pastures will support if they see a good deal. They will rent pasture for a month or two until they have sold off some of their own stock

Land Capacity

Although physiography varies a great deal from one reach to another, and even within reaches, there are still macro-characteristics which influence regional land values if extremes are considered. Most land in Guanacaste has productive limits placed on it by the dry season, and will sell for the same price. For example, on many of the 'minor' slopes (15-30%) of the Nicoya Peninsula, soils developed on site have a dark brown A horizon of clay-sands overlying a B horizon in the process of laterization: pastures on these soils are capable of carrying one animal per manzana. This type of land has the same value as much better land with limited slope characteristics.

One report states that 46% of the Nicoya Peninsula is suitable for cultivation and 49% has very limited soil capacity and should not be used for cultivation.[24] However, the 46% would also be suitable for pastureland, and a fair proportion of the 49% would also be able to support one animal per manzana even though it would not be a generic resource practice. Undoubtedly much of this poorer land should not be used for grazing.

There are areas within Nicoya where the land capacity falls below one animal per manzana. Much of Region XC has slopes of over 30%, and thin, infertile soils subject to erosion have developed directly on bedrock. Where pasture has been established on these hills the grass is very short and patchy, being interspersed with bedrock and bare ground. These types of areas are extensive along the upper reaches of the cordillera of Guanacaste Region III was delineated to enclose areas where the carrying capacity was below one animal per manzana. There are hilly areas within this region similar to that mentioned above, but Region III also has extensive lava flows which have been recently deposited. Many ranchers do not bother clearing this vegetation but have encouraged the development of grasses by repeated burning.

The actual grazing capability of the above types of land is very difficult to determine, as for the most part there is free and uncontrolled grazing year round. However, estimates by individual ranchers range, according to the particular area, from two to ten manzanas per head. The areas shown on the land value map as being under ₡200 are highly undesirable primarily because of poor physiographic factors.

Peak land values of over ₡1,000 per manzana are also due to beneficial extremes of the physiographic environment. These are areas which are flat, often with rich alluvial soil, and highly suitable for machine cultivation. Castro's report on the Nicoya Peninsula states that no more than 5% of the total land area is suitable for the cultivation of annuals such as cotton. The richest of these areas is located in Region IB where land values can reach ₡1,500 per manzana. These lands are bought because they will be put into cultivation at once or for speculation, anticipating that they will be needed for cultivation purposes in the future. A secondary peak in land values is found around Cañas where soils derived from volcanic ash are fairly fertile. Land here is not as expensive as around Filadelfia, for example. In some of the fertile alluvial valleys around Nicoya land values are also high, due to the fact that they could be used for machine cultivation. South of Nicoya there are many well watered, fertile valleys which create minor highs in the land value map if they are large enough.

Where such high value lands are used for pasture purposes, the dry season limits capacity to one animal per manzana. However, a few ranchers are introducing innovations into cattle production such as machine planting of new grass varieties, machine haying and so on. Level areas are the only areas where these mechanized ranch operations can take place. Thus even discounting their suitability for commercial crops, land values would still probably peak in the same areas.

Accessibility

Accessibility plays a very nebulous but real role in determining variations in land values. It is noticeable that peak land values are centered along major paved highways. The cultivated areas are closely tied to main access routes and have consequently the highest land values. Other areas of equal advantage but without access, as for example valley areas of southern Nicoya, attract very little commercial cultivation. Good communication facilities for ranchers is not as important as it is for commercial cultivators but they are taken into consideration when buying land. As long as cattle can be driven in one day or less to a place where they can be transported to market by truck, then land values are higher than if the rancher had to take two or more days. Access by truck is very important. This is especially true of the engordaderos who dislike walking a fattened animal great distances because of the ensuing weight loss. These ranchers have to bring in their merchandise as well as take it out, doubling their traffic flow. Engordaderos consequently tend to pay a little more for good access than do criadores. Beyond this however, land values drop quite suddenly, as noted in the southern Nicoya Peninsula and areas north-east of the Pan-American highway. A special case is to be found around Nicoya to where a paved road was completed in 1968. Land values immediately shot up to over ₡1,000 and there was a good deal of speculative activity. In all probability land values will stabilize at a slightly lower value than in the first part of 1968.

In some cases, people will pay more for better access because they want ease of access more for personal reasons than for reasons of market accessibility. If the rancher is very wealthy and has his own plane and airstrip then access does not present a problem. But a person who works in San José and commutes on weekends by land, needs year round road facilities and is willing to pay for them.

A special situation exists for those ranchers who sell breeding stock. In Guanacaste they have congregated along the Pan-American highway, as easy access is important for two reasons. First, their customers usually come to them, so good access by road is essential.

Some ranchers in Guanacaste advertise their products (Output III) along the Pan-American highway to attract additional clients. Second, their outflow is often in terms of one or two animals at a time. The traffic generated per unit of area is thus much higher for these breeding ranches than it is for others, in this case good access means less expense.

The land value map based on climate, land capability and accessibility gives very general patterns as to the existing values of land inputs. However, if one were to purchase an individual ranch, then the actual cost can be further refined using an additional three variables. These are: existing patterns of land use, fixed capital investments; and ranch size.

Land Use

When buying land for beef cattle production, the first consideration is the amount of land which actually can be utilized without any additional expenditure. Or conversely, that area of the ranch which cannot be used. In most cases this is equated with forestland in Guanacaste. There are heavily forested subregions which, when large enough, have been taken into account in constructing the land use map. Most Costa Ricans, faced with a choice of buying established pasture or forestland, will discount the forestland by that cost which is needed to bring it into production. Many further depreciate forestland, as in Guanacaste forest is often allowed to exist on the poorer parts of the ranch where the carrying capacity is judged to be below average. In the frontier areas the discount will be much less as forest is bought to ensure future room for expansion. Forestland always has some value, as cattle graze there during the dry season.

The method of clearing forestland in Guanacaste is, with few exceptions, by manual labor using machete and axe. There are two methods of obtaining labor; either the rancher uses his own hired help, and own labor, or the job is contracted out. The workers themselves almost invariably receive the ¢1.25 per hour which is the minimum wage in Costa Rica. The cost per manzana varies considerably with the density of vegetation being removed. In the lightly wooded charral areas of Region III for example, the cost may be no more than ¢100 per manzana. But with better rainfall conditions, as along the cordillera and southern Nicoya, a higher and denser vegetation prevails, causing costs to go as high as ¢200 per manzana.[15] During the dry season, the dead material is burned.

Ranchers in Guanacaste have experimented with bushmasters and bulldozers in clearing land, but results have been discouraging. As long as there is cheap, abundant labor these ranchers feel that mechanized clearing is too expensive.

An additional expense after clearing is curtailing forest reinvasion. In Guanacaste, at least three cuttings need to be completed on newly cleared land, whereas the normal is one or two. This additional expense could run up to ¢100 per manzana. Newly cleared land cannot be used immediately, but a waiting period is necessary until pastures become established. In Guanacaste, with Jaragua grass, this waiting period is approximately one year.

If clearing of forest is equated with zero cost for the first three ranch size categories, as they use idle paid labor, then ranches in Size D are the only ones who pay out hard cash. Two hundred manzanas at total cost of ¢300 per manzana is a substantial outlay of currency. This ¢300 depreciation, when coupled with poor physiography or accessibility, could easily put land below the ¢200 isotherm on the map.

While forest use drives land values down, the presence of bajures raises them. It is extremely difficult to obtain actual value figures on these, as their importance in the dry season has entirely precluded sale. A cycle is found here; the higher profits which derive from limiting weight losses allow ranchers to demand even higher prices for bajure land. He also considers surrounding, non-bajure land as having a higher value because it complements and saves the bajure for the dry season. A modest estimate would value bajure land as roughly ¢200-300 above existing land values in the region. Improved bajure could possibly double in value.

Fixed Capital Investments

When buying a ranch, it is assumed that all fixed investments will be sold with it. This includes such things as buildings, corrals and fences. Movable investments such as cattle and machinery have to be negotiated separately. One variation is quite noticeable, criadores tend to sell their breeding stock with the ranch if possible, engordadores almost invariably sell their stock on the open market.

The most important building on all ranches is the house. On many of the smaller ranches, Sizes A and B, it is often the only building outside of storage facilities for feed crops. There is a correlation between ranch size and value of house. In Size A, the ranch house is usually constructed of planks, with an earth floor and either a plank, tin or in isolated areas even a thatch roof. It usually is three rooms, the kitchen oven is sometimes outside in a separate shed, and does not have facilities such as running water. With increasing ranch size, planks are replaced by serrated sawmill lumber, the floor is wood, manufactured doors and windows appear and the roof is made of shingles. The kitchen is incorporated into the main building and there are facilities such as running water. In areas where there are electric cooperatives all these ranches usually have electricity. Values for these houses range from ₡3,000 to ₡20,000.[16]

For ranches in size categories C and D, houses can become elaborate and valuable, ranging up to ₡100,000. These houses often have all the modern facilities, including private electric generators if public electricity is not available. The very large ranches are usually owned by absentee owners who frequent their ranch only on weekends; their ranch houses are often less substantial than those of small ranchers who live on the ranch. However there is adequate provision made for an administrator's house which can be better than the main house of surrounding ranches. The large ranches often have a certain amount of hired labor housing built on the ranch. The value of these is not great, usually no more than ₡3,000, resembling a ranch house of a poor Size A category.

In addition to the house, ranch sizes C and D often, but not necessarily, have other buildings such as barns, machine sheds, storage facilities, and so on. Other types of fixed investments are corrals, water wells and tanks, weighing scales, metal or wooden squeeze chutes, loading ramps and parasite baths. All of these are found only on the largest ranches, where they add as much as ₡200,000 to the value of the ranch headquarters area.

There is one other important fixed investment which is common to all ranches, and that is fencing. The cost of constructing fences is estimated by the Banco Central de Costa Rica at one colon per vara (thirty-three inches), but the average is somewhat higher.[17] If fence posts are not obtainable on the ranch, costs could go as high as ₡2.50 per vara. The actual total value of fences is determined primarily by the number of divisions found within the ranch. The rule of thumb used by most ranchers is that 10% of fence costs are depreciated every year as a result of posts rotting and wire rusting. There is also a certain amount of damage done by cattle. In Region IV and in southern parts of the Nicoya Peninsula, living fences dominate, and in these areas very little maintenance and replacement is needed.

The influence that capital investment plays is again very nebulous. If the ranch is sold to an outsider, buildings can play an important role, if the land is being added to a neighbor's ranch, buildings can be almost valueless. In any sale, capital investments are undervalued a great deal, and can add from zero to a maximum of ₡50 per manzana to land values. Large ranches with huge capital investment do not come on the market.

Ranch Size

This variable pertains primarily to demand relation by other ranchers. A Size A or B ranch will be very much in demand by others of similar size, but the cash capability is often deficient. If they are near Size C category, optimum conditions prevail -- a high demand

and good possibility of a cash settlement (through bank loans, etcetera). Size D ranchers rarely buy land; their interest is almost wholly focused on internal improvements. Some of the Size A and B ranches do fold because of emergencies, and their degree of desperation and situation with regard to neighbors often drives prices very low. Size C ranches are often financially solvent enough to absorb other ranches of similar size, and demand among these is high. Prices also tend to be high, as the seller is often reluctant and can afford to consider many offers over a long period of time. It is this size ranch which functions most in an open market.

Ranch size D also brings a lower value than one would expect, simply because it is too big. People are unable to borrow enormous amounts of money, and it is extremely difficult to gather several buyers simultaneously so the ranch can be divided. The seller does not wish to have residual land; he is selling in most cases so he can move out of the region. Several examples are to be found in Guanacaste of ranches in receivership. A sale is made involving large amounts of credit, the buyer runs out of money before he can organize an adequate production function to pay expenses and interest, and bankruptcy is declared. Some ranches have changed ownership six to seven times in as many years, with the bank still having control and selling for slightly less every year.

Summary of Land Values

In order to better understand the relationships involved in determining land values, a multiple regression analysis was run on seventy-eight samples. The basic formula used is

$Y = A + B_1X_1 + B_2X_2 + B_3X_3 + E$

where

Y = land value expressed in colones, the dependent variable,

B_1 = the regression coefficient of X_1,

X_1 = a factor of physiography,

B_2 = the regression coefficient of X_2,

X_2 = a factor of the number of months in the dry season,

B_3 = the regression coefficient of X_3,

X_3 = a factor of accessibility, and

E = a random error variate.

These three variables of physiography, dry season, and accessibility were given an assigned number for every Y. Each Y represents a point or ranch in Guanacaste where the rancher indicated a specific value for land. Many points outside the formal sample were taken.

Physiography (X_1) is broken down into five categories:

1. Extremely rough country, with poor to no soil cover and excessive slope. This land is used only for very extensive grazing (up to ten manzanas per animal).
2. Land of below average quality, but sometimes with planted Jaragua pasture. These areas are able to support 0.5 to 0.2 animals per manzana.
3. Average pastureland with moderate slope and soils capable of supporting pasture with a carrying capacity of roughly one animal per manzana.
4. Land with gentle slope and good, thick soils. Capable of supporting more than one animal per manzana.
5. Flat, fertile land suitable for cultivation by machinery.

The basic assumption is that as these numbers increase in the regression, there will be a corresponding increase in land values.

Climate (X_2) as regards the dry-season length was put into three categories:

4. A four-month dry season, taken to the nearest month.
5. A five-month dry season.
6. A six-month dry season.

The basic assumption here is that as the numbers increase, there will be a negative response and land values will go down.

Accessibility (X_3) was subdivided into four categories:

1. A paved road to the ranch.
2. An all-weather road to the ranch.
3. An all-weather or paved road within one days trail drive, with time to conduct the sale of the animals and return to the ranch.
4. The driving and marketing of animals would take more than one day going and returning to the ranch.

The same assumption as for climate is applicable; as the numbers increase, the land value should decrease.

These assumptions were borne out to a certain degree as the partial correlation coefficient was $X_1 = 0.78$, $X_2 = -0.22$, and $X_3 = -0.43$. The regression values were: A = 533.15, or rounded to 530,

	Variable Number	Mean	Standard Deviation	Regression Coefficient
Y	1	647.44	291.20	
X_1	2	2.85	0.98	219.76
X_2	3	4.67	0.84	-53.45
X_3	4	2.44	0.82	-107.45

The average price of land in Guanacaste, according to the regression, is ₡647.44 per manzana and, using plus and minus one band, 90% of the land would be between ₡356 and ₡938. One must remember that these figures apply only to used land; unused land would easily go below the ₡200 isoplith shown on the land value map.

Using the regression formula, and substituting rounded numbers, the least desirable combination of variables would be

$$Y = 535 + 220(1) - 50(6) - 110(4) - E = ₡15 - E$$

The most desirable combination is

$$Y = 535 + 220(5) - 50(4) - 110(1) - E = ₡1,325 - E$$

The least desirable combination is unsettled, unused land while the most desirable combination is land used intensively for either cultivation or pasture.

The value of E is the difference between the predicted value of Y using the regression model and the actual value for each sample, or the residual. That this difference could be great is entirely understandable because each person would have a different opinion about what a particular piece of land would be worth. The categorization of the variables themselves would have been refined considerably. But the ranchers, when they were asked how long the average dry season was in their area, rounded their response to the nearest month because in many areas seasons do vary greatly from year to year. The same general, rather than specific, responses were given to questions determining the other two variables. Field observation widened the physiography category from below average, average, and above average, which was what the ranchers said, to five categories. The same was true for accessibility, most ranchers at first thought of accessibility as the existence or non-existence of a road.

The other factors which give a wide range of E are the minor variables of land use, capital investment, and ranch size. Even though ranchers upgraded their land value estimates to take account of these factors, there would be a great deal of variation in this evaluation.

Values of E, taken from a table of residuals, ranged from -276.0 (an overestimation) to 458.8 (an underestimation). The next highest extremes were -263.7 and 289.7, with forty negative values, and thirty-eight positive values in the regression table. Residuals indicated some trends in the correctness of the linear regression. For the most part, the regression undervalued high value land. This could be attributed to the high capital investment found in these areas and the inclusion of bajuras within the ranch unit. Conversely, the regression tended to overvalue low value land. This error could be attributed to forest cover, but could also mean that physiographic values could be discounted more than they were in these areas. In terms of regions, land in Region III tended to be overvalued, land in Region IB tended to be undervalued by the regression formula.

There is no real significant correlation between ranch size and land values, but again trends are apparent. Size A and smaller B ranches exist primarily on below average value land. If they were on prime land at one time, they have been bought out or otherwise unable to exist there. Sizes B and C ranches have for the most part average land, but the full range of values is to be found. Size D ranches have both some of the best land in Guanacaste and some of the worst. This group has either been able to grow and expand on profits derived from good land and control of bajuras, or has been able to manage extensive herds on even more extensive, low value land.

Making the following assumptions

a) Pasture value for Size A ranches equals ₡600, for B and C, ₡650, and for D, ₡800,

b) The grazing capacity for all is one animal per manzana,

c) The total ranch size corresponds to the land use chart given on page 29,

d) Forest land is depreciated ₡200, bajura land is valued at ₡200 above pastureland, and cultivated land is valued at ₡300 above pastureland,

e) Accessibility is rated 2 (using the regression classification) for ranch size A, and 1 for B, C, and D, and

f) The variable of climate is held constant,

then the following values per ranch size can be given.

TABLE II

LAND VALUE ACCORDING TO RANCH SIZE

Size	Number of Cattle	Total Manzanas	Total Land Value (PL) (in Colones)
A	10	22	5,600
B	50	67	35,100
C	300	755	386,000
D	1,000	2,700	1,640,000

The rate of return on these amounts of capital will be computed at the termination of the text. An idea of the opportunity return can be obtained, however. The Costa Rican public can buy bonds issued by the Instituto de Comunicaciones y Electricidad. These are backed by the government and return 8% interest annually. Naturally there are many examples of better or worse investments, but these are blue chip ventures. These opportunity return figures are those, therefore, to be incorporated into a cost-benefit model to be constructed at the end of the chapter.

Pastures

The extensive areas of pastureland are the dominant aspect of the landscape as one travels through Guanacaste, although first impressions can be somewhat misleading. If one travels from, say, Cañas to Nicoya along the Pan-American highway and Highway 21, there is a scattering of fields put into cotton and other cultivated crops. Even though these fields are quite large in terms of acreage, they are reduced to insignificance by the surrounding pastureland which hems them in and dominates them. Only when the factor of isolation is measured, as in Region III, does one realize that pastureland can be relegated to a secondary role at least for parts of Guanacaste. Even in these areas, however, fences and the presence of cattle themselves indicate that the land is still utilized for grazing. A review of Table I does indicate the relevant importance of pastureland in terms of total land use.

The impression of dominance and limited choice for Guanacaste with regard to pastureland is further reinforced as, with exceptions due to environmental extremes, the grass roots structure of the beef cattle industry rests upon Jaragua (Hyparrhenia rufa). The introduction of Jaragua grass early in the twentieth century probably was the first major phenomenon leading to landscape change in Guanacaste since the introduction of cattle.[18] Jaragua led not only to intensification of use on existing grazing areas, it also expanded significantly the areal extent of the beef cattle industry. Information regarding the capacity of natural grasses to sustain cattle before Jaragua is very sketchy, being found mainly in the memories of old men or in family stories. It does seem clear that one of the major blockages to production increase was the large amounts of land necessary per animal. No specific figures can be given but impressions in Guanacaste are of thousands of manzanas supporting herds of only a few hundred head.

Jaragua spread very quickly throughout Guanacaste, encroaching upon and eliminating the various existing natural grasses. This process of succession occurred except in those areas of high altitude, extremely thin soils, or poor drainage. These uninviting areas cannot serve as a present-day basis of comparison between Jaragua and natural grasses because they exhibit extremes, not normal physiography. How much this succession was aided by man again was not researched, but the fast time to dominance does indicate considerable man-interference with the local ecology of Guanacaste. It is true that Jaragua was the inducement needed by ranchers to clear large tracts of forest; for the first time it was profitable to deforest land and plant it in Jaragua.

Jaragua does adapt well to the wet-dry climatic regime. Vigorous growth during the wet season, seeding just before and dormancy during the dry season permits continuous expansion and dominance. The major advantage to the cattle industry is that it proliferates almost as well on thin, laterized, or eroded soils as it does on fertile, productive soils.

This increased pasture productivity tremendously in most parts of Guanacaste, where laterization caused by heavy rainfall and erosion of topsoil caused by slope conditions did in fact limit production. While the cattle industry was slow to take advantage of this increasing capability of the land due to several economic factors, production did rise. Jaragua's vital significance to the cattle industry is that it shifted responsibility for the upper limit of production from physiographic factors such as soil and slope to the nature and extent of the dry season. Only in certain parts of Guanacaste, such as Region III, do these physiographic factors still set the upper parameter of productivity.

In areas where Jaragua does not do well, ranchers have a limited number of other types of grasses upon which to rely. Jaragua exhibits slow, scanty growth characteristics above 1,600 meters and in Region IV at high altitudes Calinguero (*Melinis minutiflora*) is an alternative on several ranches.[19] The ranches using Calinguero are not entirely satisfied with this particular grass because it grows only slightly faster than Jaragua, but it does have the advantage of adaptation to low fertility, coarse sandy soils. Ranchers would abandon this particular grass if something better were introduced, as a general retraction of area is foreseen for this grass.

A grass which does seem to be gaining popularity in the upland areas of the cordillera of Guanacaste is Gigante (*Pennisetum purpureum*). In these upland areas it does grow faster than Jaragua or Calinguero on good soils and where wind gaps between volcanoes allow rainfall spillover from Alajuela Gigante will stay green year round. One particular subvariety, Merheron (*Pennisetum p.*), is especially suitable to areas with altitudes over 2,000 meters.[20]

A grass adaptable to the ill-drained and seasonal flooding conditions found in bajuras and along coastal areas is Para (*Brachiaria mutica*). It does particularly well in the fine-textured, often alluvial, soils found on the lower floodplains of such rivers as the Tempisque. This is a grass which has fairly limited areal distribution now because it is easily replaced by native vegetation. But a few large ranchers have planted Para in their bajuras and have followed through with very good care until it was well established. Para should spread fairly rapidly both in terms of area and in terms of smaller ranchers incorporating it into their ranching systems. It should be noted that it cannot compete with Jaragua under well drained conditions.

Another grass, Guinea (*Panicum maximum*), was introduced into Guanacaste fairly soon after Jaragua as a complement to that grass. Guinea's major advantage is that it has a better drought tolerance than does Jaragua, staying green and a little more nutritious for a couple of weeks longer into the dry season. In other aspects, it does not compare as well. Guinea does not have as good adaptability in heavy, poorly aerated soils as does Jaragua, nor does it thrive above

1,300 meters. Another important factor in limiting its use is coarseness of the stem itself, which causes cattle to eat almost anything first. The cattle simply do not like it. Still it does have widespread, albiet scattered, distribution in Guanacaste, being found mixed with Jaragua and playing a supplementary role as the dry season approaches. This mixture leads to a distinctive landscape of Jaragua cropped short by the cattle and Guinea being left in tall clumps and patches. Only during the dry season is this surface irregularity reduced. Rarely is Guinea the dominant grass in any given pasture.

In the last decade, several new grasses have been introduced into Guanacaste, with Pangola and Star of Africa being the two most common types. So far their areal distribution has been severely limited. First, they have a scattered point distribution on fertile, flat aluvial soils of the middle Río Tempisque floodplain, the Golf coastal plain in Region IC, and the flat coastal plains in southern Region IA. Pangola is a little more widely distributed than Star of Africa because it was introduced first. It was formerly found on a couple of ranches in Region IV but has been abandoned. Apparently Jaragua can compete with Pangola under shorter dry season conditions.

Second, Pangola and Star of Africa are found only on the large ranches which again limit their spatial characteristics. Even with the survey on these grasses conducted outside the formal sample, less than 10% of ranch size C had Pangola (none had Star of Africa) and no ranch in size category A and B had either grass. But more important, most ranchers in the regions described above had tried one or both grasses only on an experimental basis. Few ranchers have become convinced that these two grasses have a place in their individual production function and are expanding total acreages accordingly.

Two other grasses, Bahia (Axonopus scoparius) and Janeiro (Eriochloa polystachya), have also been introduced on an experimental basis in the late 1960's. Janeiro requires much the same environmental characteristics as Para -- a well watered heavy soil. Bahia could become a competitor of Pangola in the flat alluvial areas, and it seems that it could compete with Jaragua on slightly inferior soils. No indications exist yet as to the extent these grasses will spread in Guanacaste.

The same thing can be said about legumes. Chick-peas were planted on one ranch and seemed to be a useful addition, but again results were incomplete. A pasture improvement experiment program carried out between 1966 and 1968 indicates that a mixture of legumes such as Stylosanthes humilis with Jaragua could increase production five times on hilly, rocky areas in Guanacaste.[21] While this innovation was not found in commercial production, it has great significance. Areas such as Region III, with physiographic limits to production, could increase pasture capacity to such an extent that it would be the dry season which imposed the upper limits here as well.

Establishment of Pastures

The discussion on forest clearing is very applicable here, as most of this land is established in pasture. It was concluded that the large ranchers are the only ones who are shifting large acreages from forest or charral to pasture. They are also the ones shifting from Jaragua pastures to Pangola or Star of Africa species. The reasons for this intensification of land use are many. Formerly the very large ranches particularly were able to return sufficient profit so that the owner could participate in the top echelon of society without much effort on his part. But in the years after World War II other competitive fortunes were being made in commerce, manufacturing, and in service industries. Land consolidation and land use intensity techniques were also taking place in the coffee industry, the other major source of traditional wealth. The rancher realized that he would 'be left behind' if he did not protect his position through rapid expansion of his ranching enterprise. The ranchers are also becoming much more cosmopolitan and international in scope, as for example sending their children to universities outside the country. This has given them a need for money which they formerly did not have. The opening of the export market in 1953 meant a higher selling price for beef cattle, and this was the final inducement for expansion which many ranchers needed.

During the 1960's land reform ideas became prevalent in Costa Rica, and these ideas were implemented by the agency known as ITCO.[22] This agency was empowered to take over areas not fully utilized, whether they were public or private property. Population pressure and demand for land were, and still are, great in some parts of Guanacaste. Several large ranches have had a history of bitter squatter occupation and expensive legal strife.

The fear that squatting would be encouraged by ITCO or that ITCO would expropriate their land has caused these large ranchers to expand pasture areas far beyond what they actually need. To compensate, some ranchers keep most breeding stock even though fertility is low. This, plus the retention of all new females produced, allows a rapid increase in herd size. Insofar as these large ranches are located between the Pan-American highway and the Gulf of Nicoya and Rio Tempisque, this is the area where rapid pasture expansion is occurring. It should be noted that a few ranches are expanding onto land which is rather inferior, so that now a few areas of Region IA have physiographic rather than climatic limitations.

Once the decision to establish or re-establish pasture has been made, the rancher then decides what type of grasses he wants. In most cases, the decision automatically goes to Jaragua as this is, after all, the 'traditional grass' and the one he is familiar with. But a few ranchers have opted for new grasses, as represented by Pangola, and these types will be given more and more consideration. Basically, once the rancher considers a new grass, the final decision rests upon the ease and cost of bringing that pasture into production, the amount of attention the pasture needs during utilization, and the results of production.

The actual establishment of pasture when contrasting Jaragua and Pangola is simplicity versus complexity, cheapness versus expensiveness. Once the land has been cleared of vegetation, Jaragua seed is scattered by hand. The seed itself is usually harvested by hand from adjacent pastures as there are no complexities caused by buying the seed. The price reflects only labor costs, ¢25 to ¢50 for up to one quintal per manzana. A maximum of ¢50 more is paid per manzana for the actual spreading. But this ¢100 is actually valued at zero by most ranchers as the collection and spreading of seed is done in idle time by hired help who would have to be paid regardless or by the rancher himself, and he usually places a zero value on his own time.

Two seeding times are chosen by the rancher. If Jaragua is to be established on former forest land, seed is spread in November. Then with the dry season, cattle browse the cut forest vegetation and at the same time trample the Jaragua seed into the ground. If Jaragua is to be reseeded onto existing pasture, the seed is spread in April. Burning destroys the seed and causes low germination, so seeding has to be done after. Seeding before the commencement of the wet season assures the rancher that the seed will be present when he herds the cattle in. That pasture is still producing, although at a lower level than the rancher would like. The cattle enter the pasture after the first rains to trample the seed into the ground and take advantage of the first flush of growth. This gives the other pastures a chance to obtain good height before the cattle are withdrawn and put on them.

In both cases, newly seeded pasture remains idle during the wet season to allow Jaragua to become well established. During the following dry season, there often is a good growth of grass upon which to graze, even though it has low nutrient and protein value. It then is burned just before the wet season, a few patches of poor germination are reseeded, and the pasture enters the normal production process.

In contrast, Pangola is costly and requires much more organization and technical knowledge. Whereas Jaragua required little land preparation, the method used in planting Pangola or Star of Africa requires that the land be cultivated. Equipment for plowing, disking and raking can be rented for approximately ₡125 per manzana and this is taken at the actual cost. Several ranchers planting Pangola also have commercial operations of cotton and plant sorghum and thus have similar types of machinery, but they calculate machinery depreciation, interest, etcetera, on these operations rather than on pasture. The few ranchers who bought equipment just for pasture improvement are vastly underutilizing their machinery. The tree trunks and stumps have already been burned off or rotted away so costs per manzana is on land which has been in use for some time. The costs of establishing Pangola directly on recently forested land is prohibitively expensive and is not done.

In most cases, Pangola seed is not produced in Guanacaste and the rancher either buys it from middlemen or journeys to San Carlos or the Meseta Central for it. Cost again is highly variable, but can run up to ₡200 per manzana. The seed is actually the root structure of the plant and needs to be cut up and spread, usually by hand. These two jobs cost up to ₡50 per manzana. It is then mechanically covered, which costs an additional ₡75 per manzana. Total cost to this point is ₡450 per manzana and should be completed before the beginning of the rainy season.

Most ranchers have been greatly disappointed with the germination rates (often under 50%) and may require repetition of the above performance two or three times. Spreading the cost out over two or three years, often the length of time needed for a good pasture, an additional ₡150-200 per manzana must be paid. In an attempt to reduce this loss, fertilizer is usually added at an additional ₡150 per manzana at the start, but this procedure has only been marginally effective. To avoid the risk of having the cattle destroy newly established Pangola, which is more susceptible to damage by trampling than is Jaragua, some rancheros do not use that land for two or even three years. The loss of use for an additional one year when compared to Jaragua is at least ₡100.

Gigante, Guinea, and Calinguero are planted much the same way as Jaragua and have much the same cost structure. The only difference is that the seed is a little more difficult to harvest and sometimes is brought in from other parts of Costa Rica. The germination rates, especially for Calinguero, is a fraction lower than for Jaragua and more reseeding needs to be done. Nowhere was the cost per manzana higher than ₡200 encountered, with many people equating the cost at zero for the same reasons as given for Jaragua. These grasses, especially Gigante, have an advantage Jaragua does not have; they can be used further into the dry season.

Para, on the other hand, is handled like Pangola, being heavily mechanized. Because it is planted on ill-drained land, timing is vitally important. In certain areas, only the last week or two of the dry season allows heavy machinery to operate, and this opportunity often comes once in every three to five years with a severe dry season. Total costs vary from ₡400-700 for initial establishment, and the germination rate is such that little reseeding is needed if it is well protected.

Pasture Maintenance

Once the pasture has been established additional comparisons can be made about the 'Jaragua group' as opposed to the 'Pangola group'. New pastures have to be maintained against the constant encroachment of weeds, scrub and even forest. The process of removing this unwanted vegetation is called a chapia. Jaragua undoubtedly is highly resistant to this encroachment and will even be strongly present when it looks as if a pasture has completely reverted to natural vegetation. Pangola, on the other hand, is not very aggressive and will disappear totally very quickly. There is some evidence that Star of Africa is more resistant to invasion and a few ranchers are considering this species over Pangola for this reason.

This characteristic of Pangola has discouraged many ranchers from planting it and has even caused a couple to revert back to Jaragua. They felt that excessive care was necessary and perhaps not worth the worry. In Guanacaste, it takes up to five years to produce a reasonably clean Pangola pasture, something which takes Jaragua only a couple of years. Only on former cultivated land which has been worked for several years does Pangola avoid this problem. Pangola chapia is a constant task for many ranchers, with continuous surveillance of a pasture to detect and remove, or spray with herbicides, weeds before they are able to kill the surrounding grass. Since the Pangola group is also more susceptible to hoof erosion than is Jaragua, additional care must be taken to prevent losing pasture because of this. This problem is especially bad after rain, when animals sink into the ground, thus destroying the roots of Pangola. Hoof erosion makes weed invasion especially easy.

Chapia is a continuous wet-season job, but individual pastures are cleaned once or twice a year. Work is done either by the individual rancher with his hired hands, or often is contracted to organized groups of people from surrounding areas.

The actual amount of work and frequency depends upon length of dominance, surrounding vegetation, size of ranch, climate, etcetera. The longer the pasture has been established, the less chapias it needs unless it has been either overgrazed or undergrazed. Both will allow malevolent vegetation to enter. Overgrazing will destroy the grass itself due to constant close cropping which inhibits the plant's ability to feed sunlight to its root structure, and exposing the plant to water and wind erosion. Undergrazing permits grasses, especially Jaragua and Gigante to reach eight to ten feet in elevation. Any shrub which gets started is thus hidden from the rancher and can tread out grass from a significant area before being discovered.

This vegetation encroaches in a stepwise fashion from surrounding vegetation; sending out creepers and runners, dropping seeds, and so on. So the larger the pasture and the more contiguity with other pastures, the less time it takes to maintain a clean pasture.

Ranch size also enters into the picture. The small rancher with less cattle than pasture will follow a cyclical pattern in pasture cleaning. As he adds an additional cow or two, pastures are cleaned and good care is taken of them. But if for one reason or another his herd declines, then less care is taken and the weeds and scrub vegetation reappears. This cycle continues until he goes bankrupt and moves away or until he can establish a steady economy through his herd or some other activity. Very few of the small ranchers do either. Ranchers in size categories B and C usually maintain very clean pastures, as do engordadores. In many cases they are actually approaching overgrazing and simply cannot allow any decrease in pasture productivity. Not only do they have to graze the animals during the wet season, but certain pastures have to be allowed to grow tall for the dry season. When they actually do overgraze, reseeding is carried out the same year.

Large ranchers are quite similar to small ones in this regard. They clear and plant a pasture, find they really do not need it, and maintain a desultory kind of chapia until they do. Then a great deal of effort is expended to clean the field. Where they feel that a pasture is losing productivity, they are often able to abandon it altogether for a while to allow tall vegetation to replenish the land. They do not usually let this process extend to where Jaragua disappears over large patches and trees begin to appear. Reclearing the area does take considerable time and expense when ranchers do bring it back into production.

Climate plays an important role as well in determining the amount of work involved in the chapias. As a general rule, the more rainfall and the shorter the dry season, the more work needed.

In most cases the actual work is done by a group of men swinging machetes. The average length of time necessary varies with the condition of the pasture, but varies between four to five work days per manzana. The day itself varies, from six to twelve o'clock or from six to ten o'clock and two to six o'clock depending upon the worker. If he has a minifundia of his own he is often able to work the six to twelve o'clock shift; if he is a laborer only the second, split day system is generally followed. The cost ranges from a minimum of ₡15 per manzana for clean pasture to ₡40 for infested ones. Average cost is between ₡25-30 per manzana. However, in Region IV minimum and maximum costs run between ₡20-80, with the average cost being ₡40.

The larger rancheros have mechanized this operation on flat level land without rocks, but still have to rely on the machete for hill land. The most common machinery is a rotating mower and tractor on a hydraulic system for raising and lowering. Average costs are under ₡10 per manzana for operating costs. Probably the only equipment that is used to capacity by some rancheros is for mechanized clearing. Thus fixed costs of depreciation and interest are spread over a large number of manzanas. A very few rancheros have also tried herbicides. While also cheap, results have not been satisfactory, as some additional machete work is required.

Clean pastures under good management often need only one chapia per year, at least for a few years. But most pastures need two, one in May to July and the other in October to November. The first eliminates those plants which respond to the wet season, while the last is beneficial in that it allows the growth of some young grass before the dry season arrives. In Region IV, often three chapias are required and this may be the major reason why no Pangola is found in that area.

A special kind of chapia is the burning off of old dead grass at the end of the dry season. Some fields have a lot of dead matter present, others have been fairly well grazed -- both are burned. This allows the cattle to reach the young grass when the rains do come, while adding a layer of ash for fertilizer purposes and for eradicating ticks. Some ranchers feel that burning helps the germination process. A few ranchers, equipped with machinery, are attempting to work out a system of plowing under the grass and replanting, however, the benefits to be derived from this are doubtful. During April, a pall of smoke hangs over Guanacaste causing temperatures to rise as the sun's rays are trapped underneath.

Two processes are involved in burning. There is a mini-chapia along the fence posts, thus preventing them from burning. In Region IV and some of the highland and southern areas of the Nicoya Peninsula, the occurrence of living fences makes this job unnecessary. The mini-chapia is usually done by contract for approximately ₡35-40 per 1,000 varas of fenceline.

Then the pasture is fired along a wide front and the fire allowed to run through pasture after pasture. In this regard there is usually a fair degree of cooperation among the ranchers. The fire is watched and not allowed into extensive forest areas, but is permitted to sweep through the scattered forested enclaves.

Cost per manzana is minimal but whether the fire is for ten manzanas or ten hundred manzanas, at least two and often more men are needed for the day. These men guard it from spreading, refire areas not properly burned, pile up grass around logs and stumps to burn these better, and so on. Additional men are often needed to shift the cattle around. Smaller ranchers sometimes burn after the first rains as they cannot obtain access to reserve pastures for their animals. In this case the cattle are taken out of the pasture, the grass is burned, and the cattle returned in a matter of hours.

Pasture Size and Rotation

Within each ranch there is a fair amount of subdivision to ensure fuller utilization of pastureland. Without subdivision the animals tend to remain close to water and/or salt locations. The pasture around these areas can become badly overgrazed while the further reaches of the pasture are virtually untouched. Pasture is destroyed in both areas, thus reducing the overall carrying capacity of the ranch considerably. Other reasons for subdivision are the controlling of breeding, the separation of classes of animals, and the need for special pastures. These special pastures are used primarily as maternity pastures to separate cows about to have their calves, young bulls which are not being used for breeding, and for young calves whose mothers are being milked for ranch consumption. Those ranches which have purebred stock often create very small pastures for these as well.

The two factors which most determine the actual size of pastures are the size of ranch and the availability of water The Size A rancher usually only has one division as he does not need to subdivide his herd, cattle wander all over this size of ranch.

But when it comes to water the rancher does run into problems. If he is lucky he may have permanent water rights on the ranch, if he is not he will have to herd his cattle to water. Water location may be on a neighbor's ranch or across public trails, in which case arrangements can be made. There are many small communities scattered around, particularly in the Nicoya Peninsula, which have their own water supply; springs, rivers, even wells. The rancher will often live in one of these towns and have a small holding pasture on his town property. Animals are thus brought here every night and watered. The water situation is really adequate during the wet season, but the dry season can force longer and longer daily migrations as water hollows in river beds dry up. One of the yearly tasks is to deepen these hollows for both human and animal consumption.

Ranch size categories B and C usually have their own water supply and in fact this supply probably was an important factor in allowing the ranch to grow in the first place. The large Size C and D ranches invariably have permanent streams upon which they depend the year round. In addition they also have several wells strategically placed in ill-watered segments of their ranches. If they do not have a spring or river, then in almost every case they have dug wells. Most ranchers strive to have water availability on every pasture. Poorer watered ranches will thus tend to have large pastures, at least until wells are dug.

Cost will vary of course with the method used and the depth of well needed, but the larger ranchers have spent over ₡75,000 per well and have two or three. These ranchers can obtain professional help in well digging either from their local cattlemen association or from the CNP. There are also professional well diggers using portable drilling equipment who will drill, pipe, and set up the energy requirement necessary. The CNP and MAG are also advocating the building of dams on the smaller, seasonal streams to conserve water for the dry season. In 1967, ₡150,000 was made available to many ranchers with technical help by the government for water improvement projects.[23]

Several types of energy are used, from a simple pail and bucket on a winch, to windmills, to little diesel or gasoline motors. Windmills probably have the widest distribution at present. It is interesting to note however, that of all types of mechanization, it is the motor for pumping water which has the greatest distribution and penetration onto the smallest size of ranch.

The location of pastures is primarily determined by the water supply. As many pastures as possible are placed about the water source. If a river flows through the center of the ranch, pastures tend to be narrow linear fields perpendicular to it. To ensure full utilization of these pastures, salt blocks are often put near the opposite end of the field. If distance becomes too great, a second layer of pastures is placed behind the linear ones, but access lanes are provided so cattle can be herded by horse to the river. Salt blocks in this situation are usually located near the water source.

If the water supply has a point characteristic, such as a well, spring, or river cutting through one corner of the ranch, the pastures are often wedge shaped with the narrow point located on the water source. Or narrow strips of pasture run parallel to each other, and then open out onto large pastures. Many ranchers who depend upon wells to a great extent and have mechanized pumps use the well to supply on the average four to six pastures. But rather than adjusting fence lines, they use plastic pipe and pump water to each pair of pastures. At each terminus in this system there is a water storage tank and a trough which straddles the fence line. One rancher had this system to supply four pastures at each terminus, moving the trough around as the cattle were rotated.

The location of the small, five manzana average, special purpose pastures is almost invariably around the ranch house. Usually only one water source, often the same source as for the house, is provided, and the cattle in different pastures have access to, or are herded to, this at different times of the day.

As the ranch size increases, the average size of pasture increases as well. Ranch size B has pastures ranging from six to thirty manzanas with the average at twenty, whereas ranch size C has pastures from twenty to one hundred manzanas with the average at fifty. The large ranches have very large pastures, in some cases open range exists, and these areas exhibit the characteristics of overgrazing and undergrazing but ranchers are striving to reduce these to an average size of between seventy-five and one hundred manzanas and will probably achieve this as they put in more and more wells.

Most ranchers follow a system of pasture rotation wherein they move animals from one pasture to another as the grass is cropped down.[24] Various methods are used to determine when a pasture is ready for cattle and when they should be removed, but it is usually based on height of grass. MAG, for example, recommends that Jaragua be cropped no lower than twenty centimeters and should be allowed to recoup to at least forty centimeters[25] Note that to the uninitiated the pasture would appear to have much grazing remaining, but in fact under twenty centimeters the pasture does begin to suffer from weed invasion. In practice, many overgraze at least some of their pastures, as indicated by heights of ten to fifteen centimeters when the cattle are removed. Generally speaking, ranchers are much more willing to overgraze pastures utilized by breeding stock than they are if the pasture is used for fattening.

With the irregular sized pastures, no general system of rotation dominates in Guanacaste. Rotations have been worked out by the rancher depending upon number of animals, type of animal, and time on and off the pasture. The most common rotation involves two animals per manzana, two pastures, and twenty-one to thirty days of grazing on each. The classic example of this rotation is a breeding herd of roughly forty animals being switched back and forth on two twenty manzana fields. During October and November, the cycle is lengthened slightly so that when the dry season begins the second pasture is still fairly high, and the first has had a little time to grow. A few ranchers do not follow a rotation scheme, but put a breeding herd on a pasture permanently Average animals per manzana are 0.8 to 1.0 per rotation.

For small pastures, a breeding herd may rotate among four pastures, fifteen days on and forty-five days off. The same type of rotation is found for novillos and bulls being fattened for market, or it may follow a three week on and six week off type using three pastures. This generally is true for large herds being rotated among large pastures. Herd size averages between 2.1 and 2.7 animals per individual pasture or 0.7 to 0.9 per rotation. Another system using the same criteria is grazing for four days on and off for eight. This short rotation gives a little better utilization of pasture and is found where ranchers have exceptionally well watered range or where there is an 'odd pasture out' in one of the other rotation schemes. The disadvantage lies in the fact that the cattle are bruised and injured more by the barbed wire fence.

Pasture rotation varies with types of grasses as well. Gigante, for example, often is given only fifteen days to regrow, thus the cycle is much faster. Para is perhaps utilized only once during the wet season and then allowed to grow nine to ten foot tall. Even at this height Para is highly palatable. Then it is heavily grazed for the four to six months of the dry season. Pangola and Star of Africa are generally used for a four or five pasture intensive rotation where it is heavily grazed for a few days and then left idle. But often these grasses are not rotated at all. The small purebred breeding herd which some ranchers are building, or the prize bulls, or animals to be exhibited at agricultural fairs, may be put on the one and only Pangola pasture.

Results of Pasture Utilization

It has been well established that Pangola or Star of Africa takes a great deal more money, time, and effort than does Jaragua.

Yet these grasses, or similar ones still to be brought into production, are considered to be viable alternatives by some ranchers in Guanacaste. The answer is very simple; Pangola appears to produce much better. The question of how much better unfortunately does not have a simple answer. There is a general impression among the ranchers of Guanacaste that Jaragua will support between one and two animals per manzana during the wet season, while Pangola will support three. It is also generally conceded that Pangola during the dry season cannot support many more cattle than does Jaragua. But Pangola has all the advantages. It is under the best system of rotation, is often fertilized quite heavily, is kept cleaner, and is watched over with constant care. The couple of ranchers in Region IV who have abandoned Pangola and given the same advantages to Jaragua find that their pastures are able to support only a slightly smaller herd.

The data by Blue give some indication of comparative growth.

TABLE III

PRODUCTIVITY PER GRASS SPECIES

Fertilization (Kilograms per Hectare)	Grass Species (Pounds per Hectare)		
	Jaragua	Pangola	Gigante
0	18,550	24,420	29,420
210	30,550		
225			43,420
248		54,340	

Source: Blue, W.G., Fertilization Experiments with Grass Pastures in Costa Rica, University of Florida, San José, 1960, pp. 12,37,30

Comparison is hard because the figures for Jaragua were taken in Guanacaste, for Pangola in the Atlantic lowlands, and Gigante from highland regions. Pangola was harvested eleven times, Jaragua four times and Gigante three times. This does reflect the total annual production however. The figures indicate that Pangola does not have great advantage under zero fertilization and a longer growing season. All grass species did respond well to fertilization.

Fertilization is carried out in limited degree only by the large ranches, with only one rancher in the formal sample fertilizing practically everything. Here, Pangola does have an advantage. Experiments indicate that Jaragua tonnage will increase linearly to approximately 170% as up to 150 kilograms of fertilizer per hectare are added, but additional amounts will cause very little increased growth.[26] Experimentation done at the Enrique Jiminez Nunez experiment station in Guanacaste do not give such linear results for Pangola when fertilized with nitrogen. As up to 600 kilograms per hectare are added, dry material goes from 2.7 to 4.01 tons per hectare; but thereafter additional nitrogen can decrease yield.[27] The same experiment, only using material such as urea, nitrate of ammonia, etcetera, showed an increase from 12.70 to 28.48 as 300 kilograms per hectare were added; but thereafter returns were mixed.[28] Assuming a value of ¢15 per quintal (one hundred pounds) of dry material produced, ¢73 per quintal of fertilizer, ¢5 per hectare application costs, then for 300 kilograms per hectare the ratio of cost to gain is 1:1.34. For 600 kilograms per hectare of fertilizer it is 1:1.82, and for all other amounts is below 1:1.[29]

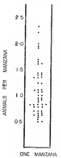
Pangola and Jaragua respond differently to fertilization with regard to protein content. There is a sharp drop of protein content in Jaragua grass from over 7% before it seeds in November to under 1.5% as it suffers the dry season.[30] The application of nitrogen does increase the amount of protein available to animals, but the increase becomes less as the dry season approaches. A harvest date of July 3 shows an increase from 296 to 638 pounds of protein per hectare as application of nitrogen is increased from zero to 210 kilograms per hectare, while a harvest date of December 15 shows, with the same application, an increase from 316 to 439 pounds per hectare.[31] An experiment at the Enrique Jiminez Nuñez experiment station shows that 300 kilograms per hectare of nitrogen will increase protein content from 6.42% to 9.33%, and additional 300 kilograms of nitrogen will place protein content at 10.00%, and thereafter gains vary a great deal with increased applications of fertilizers.[32] This is oneofthe principal points in favor of Pangola. Unfortunately, this experiment did not give protein variation as the pastures entered the dry season. It is known that protein values drop, but it is not known if they drop as much as they do in Jaragua.

This loss of protein, with other nutrients following the same pattern, is probably the principal cause of weight loss and increased mortality, as there is usually enough bulk in pastures to carry the animals over the dry season. There are indications that even animals with full bellies continue to lose weight. Part of this fullness can be attributed to water, as water consumption does go up during the dry season.

All in all, the various experiments and the ranchers' own experience do not present a convincing argument for the rapid conversion from Jaragua to Pangola. The great reduction caused by the dry season on carrying capacity, the large initial cost, and the subsequent care needed all indicate that Pangola will not be the next major step to increased production. Much more experimentation needs to be done not only with present grasses but with new plant species.

The ratio of animals to pasture manzanas under existing production functions is shown on Figure 8. These figures were collected during the wet season, during the dry season they would be lower. Maximum herd sizes are probably found during July and August, from these months on there is a heavy sell-off of animals ready for market. Just before the dry season there is an additional sale of animals born that year by criadores to engordadores who have depleted their herds and to areas outside Guanacaste.

The figures over one manzana are a result of several factors. Some criadores have large seasonal fluctuations in herd size, having substantially over one animal per manzana during the dry season, but selling off their entire production as the dry season approaches. During the dry season the animal-manzana ratio often falls below 1:1. Other ranchers depend upon extensive bajuras. If they are large enough in proportion to total ranch size animals per manzana can be appreciably over 1:1. The same can be said if extensive forest acreage exists. Although the carrying capacity is very low, cattle can survive in relatively large numbers. The size



CARRYING CAPACITY
COLUMN VECTOR

Figure 8

A and D ranches have much less fluctuation in animals numbers between the wet and dry seasons than do B and C simply because the latter have less forest and tend to be overgrazed for the most part. Probably the most determining factor is what the rancher is willing to lose. If he is willing to accept substantial weight losses, an increased mortality rate, and a longer breeding cycle for his animals, then over one animal per manzana can survive. Whether it is economically rational is open to question, but it is interesting to note that very few engordadores make this decision.

In fact most engordadores have under one animal per manzana. They not only want their animals to exist, they want them to gain weight. This requires considerably more pasture than it does for a breeding animal even during the wet season. Most engordadores, having control of bajuras in the Nicoya Peninsula, being concentrated in Region IV with the shorter dry season, and being fluid in their in their marketing structure, have much less fluctuation between wet and dry seasons than do criadores. The greatest difference in terms of function is found in those ranchers who have both engordadore and criador systems. In a long dry season they are willing to sell most of their fattening herd whether they are ready for market or not; an engordadore will never do this.

Many of the figures under 1-1 are influences by physiographic considerations in Regions III, IIB, and IIC. In these areas a great deal of land was considered pasture whereas correctly it would fall under a charral category. But as some ranches have very little pasture acreage as such, a fallacious impression would have been given conversely if this charral were to be excluded from the ratio.

One rotation system advocated by Fertica for dairy animals in the Meseta Central area is being considered by a couple of ranchers in Guanacaste.[33] This is the thirty pasture, one day grazing which would increase the carrying capacity of the pasture by obtaining 100% grazing. A thirty day growth cycle is considered the optimum for pastures if it is fertilized, a situation, by the way, which Fertica encourages as it is the largest producer of fertilizers in Costa Rica. Five manzana fields using Pangola or Star of Africa and grazing fattening stock seem to offer the best possibilities, but much experimental work would have to be done to meet the local situation.

Combatting the Dry Season

Because the dry season plays such an important role in every aspect of the beef cattle industry, many of the measures taken to combat it have already been indicated or discussed

Take for example the shift in the areal distribution of cattle Seasonal migration of animals assumes major proportions The large ranchers in Regions IA and IB move thousands of animals away from areas bordering the Pan-American highway or Highway 21 to bajura areas adjoining the Río Tempisque and Gulf of Nicoya. This movement is completed by the end of December, and the migration is not reversed until sometime in May The engordaderos along both sides of the Nicoya Peninsula have sold their marketable animals by December and are able to absorb additional thousands of head from the interior on their bajuras. The same is true for engordaderos in Region IV, they also buy and transport thousands of animals from the Nicoya Peninsula and other parts of Guanacaste.

Ranchers in Region III move their animals into the cordillera of Guanacaste to take advantage of the overspill of rain from the Atlantic region. A few ranchers from as far away as the canton of Nandayure have obtained land in the same area and have preserved it for their most valuable cattle for grazing during the dry season. Ranchers have even gone further; some have actually bought land in the Atlantic coastal plain and now permanently transport young livestock to this area in December to be fattened for market. This is a trend which is just beginning to gain momentum; much more of this intra-regional movement will certainly take place in the future.

Yet the majority of cattle are still trapped in areas of severe drought. Prudent ranchers who have bajuras open these for grazing, and the larger ranchers add Para as part of the ecosystem. Forests are also relied upon heavily. These forested areas may have already been part of pastures with the fringes having been browsed by cattle seeking shade. But during the dry season, cowboys force the animals deep into forest areas every day and let them graze back to water sources by night. The forest does have many plants which have edible parts. The Guanacaste tree (*Enterolobium cyclocarpum*) and the Guapinol (*Hymenaea courbaril*) both have edible pods which are eaten during the dry season. The Palma Real (*Scheelea macrocarpa*) and Guacimo (*Xylosia grandiflora*) produce fruit and seeds which are highly edible and high in oil content. Plants such as these are often left when the forest is cleared, but little active effort is made to propagate them along water courses or fence lines where they would be noncompetitive with grasses. Many ranchers feel that trees, although they provide the necessary shade to decrease transpiration, are competitive with grasses for the limited supply of water.

Most ranchers have allowed some pastures to reach high elevations before the dry season, enabling animals to sustain normal rotation for a couple of months. Thereafter, the rotation breaks down and all pastures are opened. Fatteners and pregnant cows can freely select nourishment from any number of pastures set aside for grazing, unpregnant cows still need special pastures. The very small rancher can do little but sit back and watch his cattle lose weight and weaken, he simply has no access to new areas.

In very flat areas, a few ranchers have created a system of flood irrigation. A drainage ditch starting from a river is dug and contoured through several pasture areas before being diverted back to the river. This ditch is periodically blocked and water is allowed to spill over and flood surrounding pastureland. This practice, coupled with good grasses, allows up to three animals per manzana to at least maintain their weight. Unfortunately, very few areas of Guanacaste can be subjected to this practice. Sprinkler or other mechanized forms of irrigation prove to be much too expensive for cattle.

Ranchers who have cultivated crops have harvested them by December. At the same time rice and cotton fields are opened for grazing. Again capacity is low, but two or three manzanas will support an animal for a couple of months without serious weight loss. Cotton is especially beneficial because after cropping by animals, succulent shoots sprout once more. Some ranchers plant maize in October and November on recently harvested fields, then turn the animals in three months later when the crop is fairly high. The same is true for sorghum, but here the ranchers harvest the grain first.

Sorghum is one of those crops which is usually machine cultivated, thus few small ranchers rely on it as supplemental feed. Costs are ¢125 for land preparation, ¢45 for seed and seeding, and ¢200 for harvesting per manzana. Taking production at an average of forty quintales per manzana, as it is planted on some of the best land in Guanacaste, this works out to a cost of roughly ¢9 per quintal. Production can range between ten and fifty quintales per manzana. On those rare occasions when sorghum is sold to other ranchers, the price is from ¢18 to ¢23 per quintal.

The costs of cotton seed, another protein supplement given to cattle, is unknown, as most costs are calculated with the cotton fiber, but cotton seed is sold for between ¢15 and ¢20 per quintal. Sorghum and cotton seed are often mixed together and placed in troughs for cattle. Amounts range from one to six pounds a day per animal, and as there is insufficient for all, only the purebred stock, breeding cows about to calve or who have just had calves, and some fatteners who were not ready for market in December receive this mixture. These practices are inadequate to increase the weight of animals, but will maintain it.

Another plant which was used as supplemental feed in the Nicoya Peninsula by the smaller ranchers was plantains.[34] The whole plant would be fed mainly to the family milk cows and some of the weaker animals. However the groves were destroyed by a disease called moca and the ranchers can no longer depend upon this procedure.

One method of combatting the dry season effects on cattle which has been given a great deal of attention and which is being encouraged by various government agencies and cattlemen associations is haying. Again, this is a rich man's game which requires machinery. A few small ranchers cut and store hay using human energy, but only for their family milk cow. Much of the machinery complements that used in other parts of the production cycle. A tractor and mower used to clean pastures of weeds can be converted into a hay mower. New machinery is a rake and baler, as this is the only method of collecting hay used so far in Guanacaste. The same situation applies in this case, that is, machinery is underutilized, as in most cases haying is still experimental. Operating costs are estimated to be just under ₡1 per bale, with the average bale weighing between thirty and forty pounds when dry [35] The best pastures are used, Pangola or fertilized Jaragua, and this is the most economical and rational use of these pastures. One rancher, using Pangola pasture, obtained 300 bales per manzana per cutting. Another rancher obtained 330 bales per manzana from moderately fertilized Jaragua from two cuttings. As the average price per bale on the open market is between ₡2 50 and ₡4.00 per bale, substantial gains can be made. It is estimated that twenty-five pounds a day are needed if a large animal is to gain one kilogram a day [36] If the animal is sold for ₡2 35 per kilogram, then a forty pound bale would return ₡3 35 or roughly the market price.

Unfortunately, most haying is done at the end of the wet season or in December when protein count is going down. Haying is practiced at this time because the bales do not need to be stored; in a few days the dry season will commence. Good pastures would be further optimized if several cuttings a year were done, growth is sufficient to hay every month to month and a half. The major problem is storage. Some ranchers are considering building wooded platforms above the ground and providing a roof so there is good air circulation for drying. The major disadvantage of this is the large capital expenditure, but it probably would be worth-while. The possibility of plastic covering was also discussed, but nothing so far has been done. One rancher in Region III was putting in a pit silage operation, but again he was finding exceptionally high capital costs and was was not sure if it would be profitable.

Various concentrates, often obtained from the CNP, the cattlemen associations, or the dairy cooperative Dos Pinos are bought and mixed in with cottonseed meal or sorghum. These provide some vitamins such as vitamin E,B12, calcium, iron, cobalt and so on. There are many different mixes that ranchers can buy depending upon his specific location, and many outfits selling these concentrates will run tests to determine exactly what is required for a particular ranch. Bought only by ranch size D and the larger ranch size C, they are used for purebred stock, breeding bulls, and sometimes for breeding cows. One rancher used a starter concentrate for calves born during the dry season, coupled with a high percentage of protein mixed as well. The maximum total cost was around ¢1,500 to purchase these concentrates, the average cost per animal was roughly ¢40. This practice is insignificant, as witness the fact that few ranches use, and few animals benefit on these ranches. Two ranchers near the sugar mill on the lower Río Tempisque gave molasses to their animals. They obtained this for next to nothing, and placed it in troughs along rivers for free choice.

One other cost which everyone has, and which is a year round essential, is salt. Salt is often mixed in bonemeal to provide Ph, and the large ranchers buy a mineral preparation, the best of which has calcium, phosphorus, iron, plus various other elements. There is no real correlation between size and the purchase of bonemeal, some very small ranchers will buy and some very large ones will not. If all three components are found, they are mixed in various proportions, as for example, 77% salt, 20% bonemeal, and 3% minerals. Salt is produced locally in Guanacaste by evaporating ocean water. The average cost of salt is roughly ¢15 per quintal. Bonemeal, produced locally at a major slaughterhouse near Liberia, costs the rancher ¢25 to ¢30 per quintal. Minerals cost from ¢100 to ¢250 per quintal, depending upon the brand purchased. In all, the average cost per animal is roughly ¢4 per year.

Summary of Pastures Cost Basis

The actual fixed and operating costs of the four sizes of ranches can again be estimated using the figures found in the text before. Fixed costs, designated F, are forest clearing and pasture establishment. Operating costs, designated V, are pasture maintenance, pasture rotation and fertilizing, and combatting the dry season. Ranch size categories of 10, 50, 300, and 1000 manzanas are taken to be representative of ranch sizes A, B, C, and D.

1) Forest Clearing

$FCC = MCC + MCCPCa + MCCe$ where

M = number of manzanas,

CC = cost of clearing one manzana of land,

PC = cost of pasture chapia per manzana,

a = the number of times an operation is carried out, and

e = cost of establishing fences per manzana.

Substituting actual values in colones, in most cases the maximum

$FCC = M(200) + M(35)(3) + M(20)$ and for

Size A FCC = ¢0

Size B FCC = ¢0

Size C FCC = ¢0

Size D FCC = 200(200) + 200(35)(3) + 200(20) = ¢65,000.

2) Pasture Establishment

$FPE = MPEj + MPEp + MPEc + MPEr$ where

M = number of manzanas,

PE = cost of pasture establishment per manzana,

j = cost of establishing one manzana of Jaragua,

p = cost of establishing one manzana of Pangola or Star of Africa,

c = cost of establishing one manzana of Colinguero, Gigante, or Guinea, and

r = cost of establishing one manzana of Para

Substituting actual values in colones;

FFE = N(100) + N(850) + N(200) + N(700) and for

Size A FFE = 1(100) + 0(850) + 0(200) + 0(700) = £100

Size B FFE = 5(100) + 0(850) + 0(200) + 0(700) = £500

Size C FFE = 30(100) + 5(850) + 0(200) + 0(700) = £7,250

Size D FFE = 100(100) + 25(850) + 0(200) + 25(700) = £48,750

3) Pasture Maintenance

VPM = MPChja + MPCmja + MPCbja + MPCpa + Mc where

N = number of manzanas,

PC = cost of pasture chapia per manzana,

h = hand chapia

m = machine chapia

b = burning pasture at the end of the dry season,

j = indicates Jaragua pasture,

p = indicates Pangola pasture,

c = maintenance of fences, and

a = number of times the operation is carried out.

Substituting actual values in colones:

VPM = M(30)(2) + M(10)(2) + M(3)(1) + M(15)(4) + M(4) and for

Size A VPM = 10(30)(2) + 0(10)(2) + 10(3)(1) + 0(15)(4) + 10(4) = £670

Size B VPM = 50(30)(2) + 0(10)(2) + 50(3)(1) + 0(15)(4) + 50(4) = £3,350

Size C VPM = 275(30)(2) + 25(10)(2) + 300(3)(1) + 5(15)(4) + 300(4) = £19,400

Size D VPM = 800(30)(2) + 200(10)(2) + 950(3)(1) + 25(15)(4) + 1000(4) = £65,000

4) Pasture Rotation and Fertilization

$VPR = MPRw + MPRl + MPRf$ where

M = number of manzanas,

PR = cost per manzana of above,

w = cost and depreciation of wells,

l = labor costs, to be computed more exactly later, and

f = cost of fertilization per manzana.

Substituting actual values in calones

$VPR = M(3) + M(3) + M(30)$ and for

Size A VPR = £0

Size B VPR = £0

Size C VPR = 500(3) + 500(3) + 0(30) = £3,000

Size D VPR = 1000(3) + 1000(3) + 100(30) = £9,000

5) Combatting the Dry Season

$VDS = MDSf + MDSh + ADSn + ADSs$ where

M = number of manzanas,

A = number of animals (and assuming one animal per manzana),

DS = cost of combatting the dry season for A and M,

f = feedcrops,

h = hay,

n = concentrates or nutrients, and

s = salt

Substituting actual values in calones

VDS = T(370) + S(300) + A(3) + A(4) and for

Size A VDS = 0(370) + 0(300) + 10(0) + 10(4) = ¢40

Size B VDS = 0(370) + 0(300) + 5(3) + 50(4) = ¢215

Size C VDS = 3(370) + 0(300) + 30(3) + 300(4) = ¢2,460

Size D VDS = 10(370) + 20(300) + 200(3) + 1000(4) = ¢14,300

The operating costs are those which will be incorporated into the cost-benefit model to be constructed in the concluding chapter. The fixed costs need to be computed to give an idea of the profitability of ranching for each of the four sizes and for the cattle industry as a whole.

Herd Composition and Management

Ranchers in Guanacaste have two principal concerns when thinking about their own particular beef cattle production function. The first concern is to organise their particular territory, or land, into a system whereby they can achieve their goals. One goal maybe the maintenance of a production function, but more common is the desire to improve and expand organization to achieve maximum output. The various problems associated with his territory have been discussed in some detail previously.

His second major concern is the animals themselves. The energies expended on evolving systems to improve and expand pasture acreage are all for nought if they are not closely correlated with systems to improve and expand his cattle herd. Variations in the approach to cattle management by the ranchers of Guanacaste will be discussed in the remainder of this chapter.

A brief historical note is indicated. Up to the cattle year 1953-1954 Costa Rica was not self-sufficient in beef production and had to pay out hard earned foreign exchange, primarily to Nicaragua, to import meat supplies. One major breakthrough in the effort for self-sufficiency came with the introduction of Jaragua. A second was the introduction of Zebu (Bos indicus) cattle in 1920.[37] Unfortunately, while Jaragua spread quickly to all parts of Guanacaste, the Zebu did not spread past a few ranches for a long time. The widespread use of Jaragua was easy to understand. It had very low capital costs and could be subdivided and dispersed year by year.

Only Zebu bulls were introduced at the start, and the spread of this innovation was very slow. They were introduced in 1920, but the relationship between heat, the dry season, and Zebu breeding problems were not understood. They required constant care. Poor handling resulted in death and sterility, thus giving this breed a bad reputation and curtailing its spread. Initial high costs of buying and importing these animals could be afforded initially by only a few people, and often paid no return whatsoever. One manzana of Jaragua can provide seed for hundreds of ranches the next year. One Zebu bull has a limited number of offspring, and these offspring themselves cannot begin to breed for at least two years. Furthermore, these often exhibited a wide range of characteristics, from those similar to their criollo mother to those of the Zebu father. All of these factors did limit the mixing of Zebu stock into the gene pool of the cattle herds of Guanacaste. Let it suffice to say that they did finally work their way into popularity and demand.

There was another trend at this time that had a very detrimental effect on meat production. From around 1950, the Costa Rican government actively promoted the importation of purebred dairy cattle. From the 1950s the government repaid ranchers for the shipping and insurance charges of all imported purebred animals.[38] While this applied to Zebu as well as to dairy cattle, the latter entered Costa Rica in large numbers while the former did not. The government was thus encouraging the establishment of the dairy industry in all parts of Costa Rica, including Guanacaste.

The result was a top quality dairy industry in Costa Rica, but but it was a disaster for beef production. These thin dairy cattle, bred for milk to the exclusion of beef production, when crossed with the small, thin criollo animal of Guanacaste, led to a consistently decreasing capacity of the breeding herds to produce offspring capable of gaining weight. For many years after the introduction, and even acceptance of Zebu, the sheer numbers of these poor beef quality animals continued to negate the positive effects of the Zebu breeding practices. It has been only in the last ten to fifteen years that the Zebu strain has begun to dominate more than just a few herds.

The struggle to national self-sufficiency in beef was achieved primarily on increases in the cattle population. The opening up of new areas, such as the Valle General, San Carlos, and small areas on both the Atlantic and southern Pacific coasts, certainly played an important part in increasing beef production. But the most significant increase in absolute terms was in Guanacaste. This increase was due primarily to the haphazard increase of cattle as they expanded into new areas opened up and planted in Jaragua. There was no real effort on the part of ranchers, except for a very few, to deliberately increase either quality or quantity of their cattle herds.

The reasons for this were many. Until the Pan-American highway was built during World War II, the transportation and marketing systems were very poor. The prices obtained by the ranchers were not sufficient in many cases to overcome the difficulties of marketing. The local population of Guanacaste until quite recently were primarily orientated toward a subsistence economy, even large ranches sold only the traditional hides to obtain the little cash they needed. And finally, there were several huge ranches. Two at least were over 150,000 manzanas, compared to the two largest ranches now of 34,000 manzanas each. The owners of these, while controlling a large part of Guanacaste, were not interested in improving their herds as they were already deriving sufficient funds to allow them to circulate among the upper echelons of Costa Rica's society, with their resultant power, status, and prestige being understood.

The Pan American highway, the more active role of the Costa Rican government in stimulating production, and the ever increasing ties with the outside world destroyed the open range, laissez faire approach to cattle production in Costa Rica. The process of change from a rather leisurely approach to ranching to an approach based on economic rational, profits, and tight control of the cattle herds, took place roughly from 1930-1950. Some vestiges of the old system still can be seen today, but they are rapidly disappearing. There are sufficient remnants to provide some interesting contrasts with modern systems.

The following graph traces the growth of the cattle population in Costa Rica from 1949-1969.[39] The growth has not been strictly linear, but every year has shown some increase. Present rates of increase are approximately 5% per annum, this figure rising gradually in the last twenty years from 3% per annum for the period 1950-1955.[40] It is interesting to note that this increase is taking place in spite of the smuggling of young breeding stock into Nicaragua to take advantage of higher prices there.[41]

Of equal importance is the increase in quality as a result of the introduction of Zebu. The actual acceptance of these animals by the majority of rancheros is difficult to determine, but all rancheros of Guanacaste are presently convinced that Zebu stock is absolutely essential to their breeding programme. Zebu are in demand because they impart a much larger bone framework than exists in criollo stock to their offspring. These then have the ability to gain weight rapidly, and the final marketable animals are much larger if the Zebu strain dominates the criollo. From a few herds in the 1920's, there are now 331 ranches able to produce either white or red Brahman cattle, the most common varieties of Zebu.[42] The number of purebred bulls is 4,679, the number of purebred cows is 4,337, with an additional 4,598 cows which are three-quarters or seven-eighths Brahman.[43] Purebred herds are rapidly increasing in size. The importance of producing purebred, Brahman bulls is that their offspring, when used for breeding, rapidly upgrade the criollo derived herds. The distribution of Zebu blood offers great contrasts which can be found in ranch size and regional characteristics.

COSTA RICA'S CATTLE POPULATION BY AGE AND SEX

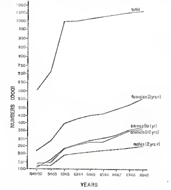


Figure 9

The organizational systems used by the ranchers of Guanacaste have already been discussed in relation to pasture. A similar approach to determine spatial and size variation can be employed in discussing the composition of the cattle population. Variations in output have already been noted and several correlations have been established between cattle population and territory, as for example, that one manzana can support one animal. Variation in this figure will not affect the present discussion, as by definition the basic classification of ranch size is based on herd size. It should be noted that in defining herd size an animal is counted only if it is utilizing primarily pasture for its nourishment. Young calves are not counted until after a ranch has been classified.

It must be kept in mind that different production organizations and methods transgress the statistical boundaries in many specific instances. The composite cattle population by ranch size is given below. Only criador ranches were used in the compilation.

TABLE IV

HERD COMPOSITION
(In percent)

Size	Bulls	Males Not Yet Breeding (Toretes)	Cows	Females Not Yet Breeding (Vaquillas)	Calves	Animals Destined For Slaughter (Novillos)
A	Population too small for percentage compilation.					
B	2.3	0.02	41.5	18.2	22.7	13.6
C	1.2	4.3	49.5	12.5	25.6	11.9
D	1.4	1.2	39.5	4.7	23.4	29.2

There are many interesting variations which one can observe by looking at the table. There are even more interesting differences which are not shown. Knowing the above inter-relationships within cattle herds, it is best to take each category for separate discussion. Only then can the full variations, both by ranch size and region, be clearly expounded. Engordadores and purebred breeding ranches will be discussed later.

Bulls

One of the distinguishing features of Size D ranches is the possession of several purebred Brahman bulls and the heavy reliance the ranchers place on them. There is no doubt that Brahman offspring, even when derived from criollo cows, are much better quality animals than pure criollo. Under the same production system, a criollo animal will take at least a year longer to reach marketable weight than an animal at least half Brahman. Some highly capitalized criadores have developed their own purebred herd for the production of these prized animals to be used on their own ranches. This internal production, coupled with relatively large capital outlays to buy purebreds, has been sufficient to have total dependence on purebred bulls on a few ranches. These ranchers are just beginning to produce purebreds for sale, thus entering competition with specialized purebred ranches producing Output III. Previously, they followed the general practice of refusing to sell purebred stock. Most Size D ranches even now rely on encastados (at least three quarters Brahman), for the majority of their breeding animals.

A couple of the very large ranches, while developing a program of breeding, still rely on native criollo bulls for some breeding purposes. There are large segments of these ranches which still have open ranch breeding practices, with only minimum controls. A cursory roundup is conducted, usually in December, to cull out those animals which are designated for slaughter, but no attempt is made to selectively breed or separate animals. These practices are found in some areas of Region IA and III where carrying capacity is low or where the ranchers are involved in improving encastado (up to three-quarters Brahman) herds while virtually ignoring criollo animals. Most ranchers are selling off their criollo herds as quickly as they can be replaced by a better quality animal.

A very few Size D criador ranchers had purebred bulls which were not Brahman. One rancher had three Charolais and another had two Brown Swiss, and it may be significant that both are located on paved roads in Region I.[44] Both were experimenting in cross breeding to achieve a better quality animal. Charolais are an entirely new innovation, just now entering Guanacaste from their main breeding areas in San Carlos. They are new to Costa Rica, as the total number of purebred Charolais bulls in the nation is only 139.[45] Their large size and ability to gain weight rapidly are characteristics which need to be explored further. The rancher with Brown Swiss was trying to develop breeding cows which would produce good beef cattle offspring. At the same time he wanted the cow able to provide large amounts of milk to give the calf a good start, especially if the calf was born just prior to or during the dry season. In 1968, some Americans introduced into Guanacaste, from Texas, the breed Beefmaster. Their intention is to produce these animals for breeding purposes ([illegible]), thus inaugurating another variety of purebred stock into Guanacaste. Another type of purebred is the Santa Gertrudis animal. There is one very small herd in Region IA which is being built up, again to function as a specialized, purebred breeding ranch.

Many of the Size C ranches also have purebred Brahman, and because the range of bulls on these ranches is from three to eight, a substantial proportion of ranchers also have complete dependence on purebreds. Many of these ranches have only had purebreds for the last five years. The results they have obtained from their first purebred have been so good that many have converted completely to these animals within the last couple of years.

In order to purchase purebreds, many have cut economic careers elsewhere, decreasing their herd size by selling their poorer cows, taking less care of their pastures, and even assuming heavy debt. This type of activity probably does make a great deal of sense if the bulls are productive. In most cases, the purebred does replace an inferior animal, but sometimes an encastado is equally as good. Some of the bulls they have obtained are actually low-quality Brahman which larger ranches have culled from their breeding programs or which are unsellable at the average high prices in demand. The status to be derived from ownership of a purebred animal, and the pride the owner takes in showing a pedigree, is ample compensation for the acceptance of a low-quality animal. Only about 5% of Size C ranches have extended this process toward purebreds to an extent where they also have purebred herds, and even in this case the number of animals involved can usually be counted on one hand.

The demand for encastado and purebred animals has not been met by supply, however, thus causing regional variation in the spread of these animals. Size D ranches will have purebred bulls regardless of location, but breeding herds tend to be restricted to Region I. Ranch size C is more likely to have purebred bulls in Region I than in Region IIA or IV, and in Region IIB, IIC, and III the probability is great that the rancher has not participated, except for one animal, in the purebred revolution. The Size C purebred herds are immediately juxtaposed to the specialized breeding ranches. This indicates that constant face-to-face contact would enable the Size C ranches either to obtain a better deal or be aware of a possible sale of poorer quality breeding stock sooner than more distant ranchers.

The more isolated Size C ranchers usually have encastado bulls for breeding. While they have been able to upgrade their herd quality to a considerable extent, it must be noted that the gene pool of the breeding herd might be still mainly criollo. A three-quarter Brahman bull crossed with a criollo cow will produce a three-eighths Brahman, and an additional breeding will produce a nine-sixteenths animal. At least four years is necessary to produce an animal which exhibits definite signs of the Zebu breed. It is probably only since 1965 that encastado bull populations came even close to meeting the demand of Size C ranches.

The demand for high quality Zebu animals is so high that encastados are just now being found on Size B ranches. The same processes are apparent here as they were for purebreds in Size C, the high demand because of status and economic consideration, the cutting of economic corners, the decrease in possession with increasing isolation, and the recent acquisition of an encastado bull

Most Size B ranches have at least one enrazado bull, primarily of the half breed variety, but the second or third bull might have little or no Brahman at all With isolation and smaller size, many Size B ranches do not own enrazado animals although most are considering buying one at present

Size A ranches, if they have a bull at all, are split evenly between offspring from enrazado bulls and from pure criollo bulls So there is often Brahman blood to be found, but it is very diluted and often does not appear under visual inspection Some Size A ranches are so small that they have no bull The common practice in these situations is to place their animals in with another herd during the breeding time, or to borrow a bull for the day or two necessary Stud fees are approximately £10 for a criollo, £20 for an enrazado, £50 for an encastado, purebreds are unobtainable The actual payment is usually in the form of labor, and if the man is fortunate enough to work on a large ranch, he can often obtain fairly good quality offspring

There was one specific example of a practice which could be very beneficial to the small Size A and B rancher if it became common practice A young encastado or good enrazado destined for slaughter would be loaned out by a large rancher to a small one for one or two years During that time the smaller rancher would obtain offspring from the bull, females of which would be incorporated into the breeding herd and males distributed to other small ranchers for breeding or sold for slaughter at a better price than pure criollo animals would bring. The large rancher would have returned to him a bull which had gained at least one hundred kilograms a year, a gain which cost him absolutely nothing but from which he obtained 100% profit. The one main drawback is the risk of losing that animal because of poor handling or disease. This is possibly one area in which the cattlemen associations or provincial or national government could organize and operate an insurance program to encourage this type of activity. Regrettably good quality semi-Brahman animals are earmarked for slaughter when they might replace poorer quality criollo bulls in breeding programs. To be sure, if ranchers participated heavily in this program, income would drop for a couple of years and some form of financial carryover or compensation would be indicated. The rancher encountered was leasing out four or five bulls a year to his immediate neighbors.

In summing up the dissemination of Zebu blood, although some has reached all levels of ranch size, the smaller and more isolated the ranch, the more diluted is the Brahman strain. There are probably more bulls with a majority of Brahman blood than criollo and sufficient numbers of purebreds and encastados are being produced that the process of herd improvement is taking place rapidly. Of the approximately 45,000 breeding bulls in Guanacaste, about 10% are purebred, 25% are encastado, 55% are enrazado, and 10% are criollo.

The one other variable of importance is the actual cost of the the bulls in question. Purebred bulls are very expensive because of the capital involved and the fact that demand exceeds supply. The average cost of shipping from Texas, Florida, or Mexico is in the order of ₡7,000 per animal. [illegible] at present always flown in special cargo planes to avoid damage; previously they were transported by ship. In addition there is a certain amount of animal loss and sometimes sterility as the animals gradually adjust to their new environment; this in spite of the constant daily care, supplement feeds, concentrates, vitamin shots, etcetera. The initial price of the bull in the United States ranges from ₡5,000 to ₡60,000, and from ₡4,000 to ₡30,000 for breeding cows. Consequently high prices are charged for Output III in order to obtain a good return on investment.

A purebred bull born and raised in Guanacaste will have an average value of ₡8,000 at two years of age. A torete at eight to nine months will be valued at roughly ₡4,000. A proven bull which has already provided offspring is valued at least at ₡12,000 and if his offspring are of high quality, this animal might be practically impossible to buy. The actual price will fluctuate a great deal, depending on the the quality of each individual bull. However, if the bull is bred and produces no offspring, then his value is equal to the slaughter value, or approximately ₡1,200. The rate of failures has not been calculated under the conditions to be found in Guanacaste.

Encastado bulls, even though they exhibit all the qualities of a purebred animal, do not sell for more than ₡4,000, and a three-quarters bull has to be of exceptional quality before he is worth ₡3,000. An enrazado which is half Brahman is worth ₡1,700. Young toretes ready to commence breeding will be discounted by one-third. Animals below this breed mixture are often sold at slaughter price. There are very few criollo bulls which are bought for breeding at the present time, [illegible] in order to accumulate a few hundred colones, plus the value of the old criollo bull, to buy at least a one-quarter Brahman.

Artificial insemination has been tried on several ranches in Guanacaste. The Costa Rican government financed a course in the techniques of artificial insemination to which several ranches sent one of their employees. Through MAG, the government provides insemination seed for both Brahman and Charolais, and private firms selling other ranch supplies also provide a supply. Artificial insemination has not proved a success in Guanacaste, due to low conception rates coupled with high costs attributed to the seed itself and the need for refrigeration until use. Many ranchers who desire a prize-winning animal have stopped using artificial insemination and once again resort to importation of bulls from the United States.

Cows

The figures on percentage of herd size reinforces what has been said previously. Size B and C ranches are primarily involved in criador operations. Size D ranches, on the other hand, are more apt to be involved in both Output I and II, having engorderdors and criador functions. The difference in percentage between Sizes B and C can be found in the difference in vaquilla percentage, to be discussed later.

The distribution of purebred cows has already been discussed, but some additional information can be given here. Half the purebred Brahman cows are to be found on the specialized breeding ranches in

Region IA. This means that the others have a point distribution and cannot really be distinguished by area. Their only function is to produce animals for breeding purposes. Sufficient numbers of purebred cows are now found in Guanacaste so that their impact on cattle herds will accelerate. The one major problem in their impact and distribution is that the ranchers who have control of purebred breeding herds have still not expanded to full capacity on existing territory, thus no purebred cows are sold except under special, high priced circumstances.

There is a rapid increase in encastado breeding animals to be found in Guanacaste, although in terms of numbers the Brahman influence is less than MAG reports indicate. Size D ranchers, with the few exceptions already noted, have for the main part improved their breeding cows to at least half-bred Brahman. Several individual herds on ranches have been upgraded to encastado status, as purebred bulls have been breeding the offspring of others for several years.

Size C ranches are in the process of replacing pure criollo animals with descendants of pure or encastado animals. Many Size C ranches have had insufficient time to upgrade their breeding herds to at least half Brahman animals. As ranches decrease in size or become more isolated a higher and higher proportion of the breeding herd is pure criollo or three quarters criollo. The breeding herds of Size A ranches are almost entirely criollo.

The cost of purebred cows is almost as much as purebred bulls, averaging ¢5,000 to ¢6,000 apiece. The price of encastado breeding females is much less, around ¢2,000, but again very few are sold as they are needed to replace lower quality animals within the same ranch

Enrazado animals are approximately £250 above slaughter price, at around £1,000. Many ranchers sell them for slaughter, in most cases only neighbors who specifically ask for enrazado animals can buy them. Ranchers see the vehicle for herd improvement as high quality bulls and internal selection of cows rather than through the buying of improved female animals.

Vaquillas

In order to understand the composition of the herd in both quantity and quality the very significant patterns involving retention of vaquillas for breeding purposes needs closer examination. Rather than evaluate the percentages found in Table IV, the vaquilla:cow ratio is more illustrative. For ranch Size B, the ratio is 44:100, for C, 29:100, and for D, 12:100. Ranch Size A would have approximately the same ratio as for D. The ratios for Sizes A and D are based upon a relatively stable composition in animal quality. An average breeding cow is replaced by a younger animal every eight to ten years, but this may be delayed several years if she is a good breeder.

Once a breeding animal has at least half Brahman blood, the decision as to whether she will be used for breeding or be sent for slaughter rests upon her ability to breed and the quality of her offspring. An animal exhibiting criollo characteristics will be sold and replaced by an enrazado or an encastado. An enrazado animal however, if she is of good quality, will not be replaced by an encastado animal simply because the latter has more Brahman blood. The possible replacement, or vaquilla, has to prove herself to be better. Thus on Size D ranches, there is a slightly faster turnover as encastados generally do prove to be better.

On Size A ranches the same logic applies. The young criollo offspring are only marginally better if indeed they are an improvement. Proof that the vaquilla can breed requires valuable space and involves some risk, therefore, vaquillas are treated as slaughterable animals. One or two of the better head are retained to replace aging or infirm cows.

In Sizes B and C, many ranchers have recently received, within the last few years, their encastado or encastado bull. The offspring from these automatically replace their mothers without trial, simply because the older animal has little or no Brahman blood. Every female offspring is kept, and because they start breeding at two years, this explains the high vaquilla:cow ratio. If the bull is encastado as on Size B ranches, this process may be repeated three or four times before the rancher rejects the assumption that the more Brahman blood the better the quality, and begins to select on quality as well as species. On Size C ranches, this cycle is shorter in duration, since the ranchers begin with an encastado or even a purebred bull.

Two results of this selection by breed occur. First, the age of the breeding herd is very young, averaging possibly five years. Because the first calf of a vaquilla is usually of poorer quality than succeeding calves, the first is sold and the second utilized for breeding. This does reduce overall productivity. Second, a one year old vaquilla takes as much space as a producing cow, so essentially there is a net loss of one calf involved. Because of this, the rapid replacement scheme is modified and lengthened since the rancher needs a producing animal [illegible] everyday working capital. Some of the poorer vaquillas might be sold at one year of age as a consequence.

The fact that some ranchers have completed the initial upgrading of the herd in Size C, and some Size B ranchers have not yet obtained the pure Brahman bull to begin the cycle, means that these particular ranches have vaquilla cow ratios similar to ranch Size A or C.

Breeding Management

The components of the breeding herds have been discussed in some detail, but their management has not. Essentially, there is not as much variation in breeding herd management as there is in pasture management, but some size and regional variations do occur.

The unit of production is the basic breeding herd which consists of one bull and several cows. The bull cow ratio is 1:18 for Size B, 1:38 for Size C, and 1:28 for Size D ranches. The Size B ranch is in the awkward position of having the wrong number of cows, too many for one or two bulls, but too few for three. The rancher will split his herd if there is more than forty cows per bull. He will buy another bull rather than increase this 1:40 ratio. Another reason the ratio 1:18 is low is because the rancher does not want to depend on the same blood lines. If he has a good enrazado bull, he wants to switch vaquillas from one bull into another bull's breeding program and vice versa. Having several bulls means that the rancher can keep them at least six years before selling. A young torete, often enrazado, breeds with a few cows the first year on all ranch sizes, tending to pull the ratio down. The same logic is applicable to a Size A ranch, one bull might service the whole [illegible] of seven or eight

Size C has the highest ratio, and this approximate ratio (1:40) is found in common practice on many ranches. A young, proven encastado bull is put into rather large herds to get maximum benefit from him. After two years he replaces an enrazado animal in another herd and a new encastado begins to breed with his offspring. Thus he can possibly exist on only one ranch for his breeding years.

Size D has so many individual herds that a good bull will rarely be sold or traded before he reaches old age. The size of the operation leads to the compilation of very meticulous records registering all animals born so that all breeding lines are fused in the correct manner. The exception again is the few ranches with some open range, where a bull could very easily breed with his own offspring. A common practice on Size D ranches is to keep an unchanging herd, using the same bull for the same group of cows until they become too old, at which time the few good animals are extracted for another few years breeding in other herds. On one ranch, rather than complicating records by shifting animals around, the whole herd is sold for slaughter as a unit.

Rather than shifting the bull, the vaquilla offspring are moved out. Vaquillas usually replace cows, one or two at a time, in other herds. However, a more common practice is to take the fifteen or so vaquillas from one herd and buy a young purebred torete from outside the ranch. If he proves himself the first year, then vaquillas (one year younger) from the same herd are added. A few cows are culled out because of poor quality or sterility, a third group of vaquillas is added to make an approximate 1:40 ratio and a basic herd of full sisters plus an outside bull is established and functions as a unit for eight to ten years.

Three other breeding practices can be found on Size D ranches. Purebred herds are very small, generally not more than twenty five head, so this tends to decrease the bull-cow ratio substantially on some ranches. Second, a few ranchers do not let the bull graze with his herd but will keep him in a separate pasture (usually Pangola) near the ranch headquarters. The dates of maximum probability of conception are mathematically computed for each cow and she is placed in the pasture for the two or three days necessary. Third, a combination of bull grazing and bull separation is followed by many ranchers. The basic herd unit is allowed to exist together, but as each cow becomes pregnant, she is removed and the bull can concentrate on an ever decreasing female population. These practices are generally followed because after a year of breeding, bulls are generally in pretty bad shape. A bull in poor health does not make a good breeder, but these management practices mentioned above do safeguard the health of the animal and make him more verile. For a cow which does not conceive easily, this can mean the difference between continuing production and being sold for slaughter. Besides the above mentioned practices, many bulls are given hormone and vitamin shots and also fed a variety of concentrates. During the dry season, bulls on Size D ranches are the best fed animals, but on the other size ranches they often suffer to the same extent as the other cattle.

Breeding cows are kept an average of ten years if they are good quality enrazadas and consistently produce offspring. See the discussion on vaquillas for variations which reduce this average time. There is a variation associated with longevity. Purebred cows can be kept an exceptionally long time even though they produce only intermittently with old age. Purebreds are the only animals which may die of old age, in all other cases the first sign of sterility means sale and slaughter. Ranches of all sizes have culling programs to rid herds of old animals. Exceptions again are those few large ranches in Regions IA and III, where they often really do not know what is producing.

The average breeding cycle for cattle in Guanacaste is approximately fourteen to fifteen months. The cattle are not able to conceive either during the latter part of the dry season or for the first couple of months of the wet season, simply because they are too debilitated. Thus if a calf is born in January, the mother often does not conceive in February for biological reasons, and then cannot conceive until July because of climate. A total of five months is lost. If a calf is born during June, for example, there is still a probability that the mother will not conceive immediately, and in a couple of pregnancies, the dry season again enters the picture. The calf crop has to be multiplied by a minimum of 0.8 in order to adjust for annual production. The practices followed below mean that for purebred herds, the 0.8 constant does not have to be included. Purebred cows receive exceptionally good care and consequently can produce offspring every year.

Size D and large Size C ranchers have taken some measures to combat this effect of the dry season, as for example, the feeding of concentrates. One thing which has to be done is the giving of Vitamin A shots to cows. Alba states that "the deficiency of Vitamin A is responsible for a reduction in fertility" if they graze on dry season pastures and furthermore this lack is responsible for many abortions.[46] There is a preparation which ranchers can buy for approximately ₡8 per injection which gives animals Vitamins A, D, and E. Very few ranchers recognize this need even for their purebred herds. This situation with the dry season and resultant long breeding cycle means that calves are born year round if maximum utilization of the cows is desired. The arguments of Grillo calling for controlled breeding according to season is difficult to accomplish in actuality although in Region IV it is more possible.[47] Purebred animals often have their offspring in dry barn stalls where the effects of weather are minimized. Because the animals are put into production as soon as possible, sometimes as soon as eighteen months of age, these herds also have calves born year round.

Two other programs are sponsored by MAG which affect the production capacity of individual cows. Law number 1207, passed on October 9, 1950, declared a campaign against tuberculosis which would effect all parts of Costa Rica.[48] On January 29, 1958, a similar law was passed in order that the country would become free of brucelosis.[49] The first disease not only weakened the breeding animals to such an extent that conception would not occur, but it was felt that the disease would be passed on to human beings. Brucelosis may cause abortions that make a breeding animal useless.

The campaign against both diseases is at present in a very inconclusive state. Animals coming into the country have to be declared disease free, but within Guanacaste only large ranches and ranches along accessible roads have been visited and tested. A veterinarian will take blood samples from all animals, and send them to a laboratory in San José. In this process many sample vials are broken and the sample has to be retaken. Ranchers do not object to the first test, but get upset if they have to round up their herds and run them through a squeeze chute again so an additional sample can be taken. If tests are positive, a tubercular animal is killed and burned, if she has brucelosis, the animal is sent immediately to market for slaughter. The control of these two diseases will continue to be difficult until all ranch herds are tested, even to the smallest and most isolated. The ranchers who have lost animals because of positive results from testing do not have marked increases in production, as they had good culling programs to begin with. It does however save space for a new breeding animal to begin production a year or two sooner.

One final management practice is followed only by the most advanced ranchers in Size D. This is the matter of pregnancy testing. A veterinarian will come around once or twice a month to test those animals which should have become pregnant since his last visit. If they are pregnant, the system of removal from the bull follows. If the animal is not, then additional vitamins, hormones, etcetera, will be given and she will be put under a more intensive breeding program. If she is not pregnant after having been bred two or three times, she is sold for slaughter and thus stops utilizing valuable pasture space and good bulls. This can cut costs appreciably. The veterinarian charges about £400 per day and he can test up to 300 animals. The real cost is involved in herding the animals, corralling them, running them through a squeeze chute, and returning them to pasture areas. This total operation probably costs £2 per head per time, and repeats run costs up to an average £3 per head.

If all the above beneficial measures are carried out in conjunction with one another, then the conception rates can reach a high of 90%. Abortions resulting from bumps, excessive running due to fright or poor herding, the debilitating effects of the dry season, the physical impossibility of some animals to go to full term, and so on, will cause an additional 5% reduction in the calf crop to 85%. Very few ranches achieve this level, and those that do are all Size D ranches. Size D also is illustrative of the other extreme, as those ranches still carrying on open range practices probably get between a 20% to 25% calf crop. Thus averaging in all Size D ranches, the calf:cow ratio is 59:100.

Size C ranches reach a high of 80% calf crop, and the majority have calf crops of between 60% to 70%. A few who have very poor records in this regard pull the ratio down to 57:100. Much the same statistics apply to Size B ranches, the ratio of 55:100 is a little lower because the maximum calf crop found was only 75%. The calf crop for Size A is rather difficult to determine. Many times the rancher will keep an animal which misses one or even two pregnancies. The average calf:cow ratio is probably below 50:100, but remember that this man often has more space than he needs. It is not too important to get rid of a poor animal until the rancher is able to continuously expand herd size.

Mortality and Health

Aspects of health which concern breeding have been discussed in the previous section. Some of the following health problems will weaken breeding stock to the point where they will not conceive, but they can be associated with part of or the complete life cycle of the animal.

Before the animal is born, the mother is often put into a separate holding pasture and remains apart from the herd until she and the calf are strong. The care given to animals at this time is intensive at all ranch size levels. If delivery is difficult, the rancher will call in a veterinarian or have one of his laborers, trained in midwifery, assist the cow if the animal is purebred or of good breeding stock. As the ranch size gets less, the incidence of this practice decreases and mortality of both cow and calf increases.

During the dry season, the cow is usually very weak. After delivery, it is the humans who dry off the calf. On the larger ranches, vitamin and concentrate shots may be given to the mother. The umbilical cord is cut near the calf and this area is covered with a medicated salve or grease. Failure to do this will result in the death of the calf as various insects, such as screw-worms, will enter the calf here and simply eat out its insides. Some ranchers estimate that this type of work occupies half their labor requirements. The weakness of the mother and the inadequate milk supply she is able to produce are the principal detriments to the calf being born in the dry season. While this might not kill the calf, it will certainly stunt his growth and he may never recover fully. The problem in the wet season is the increase in insects of all types, especially the screw-worm. If a calf rests on water-logged pasture he may lose most of his hair, another invitation to insect infestation. The possibility is considerably higher also in this season that death by pneumonia may occur. Factors operating for and against survival are present in all seasons; suffice it to say that the first couple of months of life for a calf are always extremely hazardous.

Under the best of care, at least 3% of the calves will die, and under average conditions found on most ranches at least a 5% mortality rate occurs.

The extensive open range operations in Region III and Region IA are again the exception. Ranchers really do not know what mortality rates are but they estimate that it is over 20% within the first month. Besides difficult labor and insects, two other problems not found on other ranches are present. Vultures will quite frequently pick out the calves' eyes and eat his entrails while the mother is still too weak to defend her offspring. Coyotes are the other hazard. Cattle will often protect each other from this menace, but losses are high irregardless.

The young calf almost immediately picks up a wide variety of internal parasites such as *Haemonchus contortus*, *Moniezia sp.*, and *Neoascaris vitulorum*. These are almost impossible to get rid of permanently but a weak animal, if purged of these parasites, is often able to recuperate before they again multiply to dangerous proportions. On larger ranches, a wide variety of commercial injections can be given. On the smaller ranches, purges can often be given in liquid form. It is a fun thing to rope an animal, wrestle it to the ground, and give it its yearly bottle. It is fairly common on all ranches to treat all animals for internal parasites once or twice a year; such treatments are administered a couple of months before the dry season so the animals can store up fat, and at the end of the dry season so the animal can regain weight faster.

Other diseases which the calf may acquire during his life cycle are blackleg (caused by *Clostridium chauvoei* and *Clostridium septicum*), anthrax, and septicemia hemorragica (caused by *Pasteurella multocida*).[50] These are fairly well controlled in all ranch size levels, although the smaller ranches sometimes ignore the preventive aspects. Several pharmaceutical companies in San Jose sell a variety of internal and external medicines in the form of powder or vaccinations. It is the salesmen from these companies who have vigorously pushed these medicines to all parts of Guanacaste; in fact, medicines are the most widely spread of all types of innovation to be found. Anaplasmosis is not common in Costa Rica, although imported purebred bulls from the United States are highly susceptible to this disease. A scare about hoof and mouth disease (called Fiebre Aftosa) did not materialize; there has been no incidence of this disease in Costa Rica.[51]

Insects which bother animals are the torsalo (*Dermatobia hominis*), tábanos (*Tabanus sp.*) and ticks (*Boophilus sp.*, *Amblyomma sp.*, and *Ixodes sp.*), plus the ever present mosquito and other minor insects. The tresalo is the more serious insect, burrowing into the side of the animal and laying its larvae. This makes the animal very unhealthy as all the antibodies try to fight this foreign matter, and while the tresalo itself is not a killer, it does open the way for other types of diseases. If tresalo larvae are present when the animal is presented for the export market it is rejected and cannot be sold until the tresalo have been eliminated. The larvae do destroy a great quantity of meat. They also destroy the hide, as each larve has a large breathing hole.

Tábanos are a swarming type of fly, rarely found, which can drive animals crazy. These insects can cause animals to lose weight by forcing them to move around constantly day and night. Ticks are more insidious. Given sufficient numbers they can deplete an animal of its blood supply. But of greater danger is the possibility of tick carried disease such as Piroplasmosis, caused by *Babesia bigemina*. While native born stock have developed some immunity, imported animals are highly susceptible.

All the above named insects proliferate under forest cover. Thus some of the large Size D ranches have a great deal of trouble, while many Size B and C ranches have relatively insect free cattle herds. The tresalo is not found in the drier parts of Guanacaste, but increasing moisture and precipitation in southern Nicoya and Region IV make it a very grave threat.

The control of these insects is again medicinal in nature. On the larger ranches, a special bath is built through which animals must swim. In the process, any one of several commercial pesticides added to the bath kill the insects In some of the wetter parts of Guanacaste this is done every two months, in other parts it is done twice a year. The smaller ranches often have a hand spray which they use. For tocalo, some ranches brush on grease or thick oil. This cuts off the larvae's air supply and kills them

The control of all the above named parasites is relatively inexpensive The control of internal parasites and diseases is approximately £4 per animal The same costs per year can control the external insects and reduce them to insignificance Novilles destined for market are treated more often and have marginally higher costs, a cost which pays for itself many times over The cost of labor, however, is sometimes very high.

There are many other health problems which are not as easy to pinpoint. Isolated reports have one rancher losing half his herd in a matter of days, another losing three or four animals for no apparent reason, and so on. There is a government veterinarian in each canton who can look at these incidents, but if the reports indicate that the cause of death was not contagious, he will not go to the ranch because of pressing demands elsewhere [52] In most cases, these pressing demands originate on Size D ranches Large ranchers can obtain veterinarians when needed, but those owning small ranches cannot. The cattlemen association in Guanacaste has its own veterinarian and pays all costs except transportation But he too is kept busy by the members.

Sporadic deaths have to be explained somehow, so most of the smaller ranchers blame them on venomous snakes. The larger ranchers generally place the blame on the bad effects of the dry season It is certainly true that mortality of large animals goes up as the dry season continues.

One experiment was conducted to prove that a shrub called Escobilla morada (Melochia pyramidata sterculiaceae) was poisonous to animals.[53] The test proved toxicity, and a warning was given to ranchers on the Nicoya Peninsula where it was found. There are suspicions that several other plants might also be toxic, but no tests have been conducted. The animals themselves seem to know, however, and it is only under very severe prolonged dry season conditions that animals will eat these plants.

It is difficult to estimate mortality losses in terms of percentage. Many ranches have insignificant mortality losses while others lose several animals a year. The mortality rate for Guanacaste is 5% for breeding cattle and drops to 1% for novillos, these rates being constant for all ranch sizes.

Labor

Labor requirements for cattle are very minimal in relation to the number of animals involved. The determining of labor value and the requirements involved are computed only for the herd management operation, both breeding and output sections. For the main part labor centers on the protection of the animals' health. Except for a few jobs, one rancher can handle up to 300 head without having to hire outside help. In many cases his family helps out. A small boy, for example, can drive the cattle from pasture to pasture and check the health of the animals.

The few specialized jobs often give people on the smaller ranches a reason or opportunity to [illegible]. Vaccinations, branding, and castrating are all multi-men jobs Branding and castrating are done once every year when the calves are weaned , at approximately eight months At this age the animal is much more able than when younger to survive the hazards and infections of these operations, but he is very difficult to handle even by two men Therefore, a group of ranch owners will move from one ranch to another until these jobs are completed

Even the largest ranches employ no more than twenty permanent men, although it should be noted that the care given to protect the animals' health is not as good as might be expected

The cost of unskilled labor (peones) is usually the minimum ¢1.25 per hour, and averages between ¢50 and ¢80 per week. If a man is an exceptional worker and has seniority, he is given some supervisory responsibility and is paid ¢2 per hour Some ranchers pay by the month. These wages range from ¢250 to ¢350 for unskilled labor. Savaneros (cowboys) are considered skilled workers and are invariably paid by the month. Their minimum salary is ¢350 and if they are given supervisory positions,they can earn ¢500 a month. One savanero may be found on large Size C ranches, and only five or six are found on the largest ranches of Guanacaste.

On top of the monetary wage, peones are usually given one meal a day. They may obtain a house and a little land for subsistence crops The savaneros are always given these privileges

Administrators usually supervise the day to day operations of the very large ranches that are owned by absentees Important decisions on investment and marketing are always made by the owner however

The administrator is given a house, use of ranch transportation, and a salary of approximately £2,000 a month. The large ranchers usually retain an accountant in San José as well to handle financial matters.

For ranch sizes A, B, and C the labor costs are often equated at zero because labor is done by the family. For Sizes A and B, labor devoted to animals is probably not equal to that given to other ranch requirements, while for Size C animal labor requirements might consume almost all of one man's labor. Taking an estimate for the cost of labor not already computed, labor costs (VL) are for:

Size A VL = £100, assuming ten working days and peon labor wages,

Size B VL = £500, assuming fifty working days and peon labor wages, and

Size C VL = £5,200, assuming fifty working days and sabanero labor wages.

Size D ranches are the only ones which can be computed with any degree of accuracy. Counting one administrator, one accountant, two sabaneros, and four peones necessary to handle a 5,000 head ranch, then for a ranch size of 1,000:

Size D VL = £14,000

Credit Requirements

There is a great deal of credit available in Costa Rica for cattlemen.[34] The maximum, or tope, amount of money which banks could loan to people involved in cattle production, hunting, and fishing was 247.8 million colones in 1968.[35] The great demand for credit is seen in the fact that in 1964 the tope was only 152.6 million colones for the same category. The tope is set for the various economic sectors by an autonomous agency, appointed by the government to ensure that the supply of money in the total economy does not outrun productivity, thus initiating inflation. The cattle section has been given a substantial tope increase every year, with the agricultural sector (mainly for coffee) tope stabilized to avoid overproduction and the consequent decline in prices.

The establishment of topes has led to a situation of supply and demand imbalance. Most international agencies such as the World Bank require matching funds from the Costa Rican government. But these matching funds are controlled by topes, causing colon unavailability and consequently international money often lies idle. At the same time, cattlemen complain that they are unable to obtain credit because of unavailability of money within the banks themselves.

This excessive demand has led to inequalities in the system of bank credit. Large Size D ranchers and most Size C are able to obtain money with relative ease. Anyone who has not established credit has an almost impossible task. There are reams of red tape, constant investigation by the bank into land holding titles, financial posture, etcetera, and the waiting period is so long that most people give up in disgust. For the small rancher, the same process may be repeated two or three times, once for each loan, before he is considered a good credit risk. Once the loan is given, banks can continue their investigations to ensure that the money is used for the purpose requested. The Central Bank publishes a book listing all the requirements with which a rancher must comply, the book is very detailed.[56]

The Central Bank is correcting some of the above mentioned faults. The bank department of Oficinas de Credito al Pequeño Agricultor funnels money directly, and through other banks, to the small farmer. Regulations have been eased to a certain extent and some technical help can be obtained in conjunction with the loan if desired. However, in 1968 the Central Bank allocated only 20.9 million colones for all types of agricultural endeavors under this program.[57]

Loans are classified by purpose. There are loans to buy land, breeding cattle, novillos for fattening, to improve pastures, capital investments, and so on. There are no consumer loans under the above mentioned type.

Terms are quite liberal, but mortgage requirements may be stiff. To buy breeding stock for example, a rancher can obtain up to a ten year loan and pay only the interest for the first three years. This allows the animal to produce one offspring ready for sale in time to meet the first capital payment. The mortgage value of that animal is the slaughter price, however. The bank is fairly certain that this price will be received if bankrupcy is declared; it cannot be certain that the animal will be a satisfactory breeder when the loan is negociated. To buy novillos is a different matter entirely. Loans are made for one year if the animal is two years of age, for two years if the animal is one year of age. The mortgage value may be 100% however, which means that an engordadero can operate almost entirely on credit, with very little of his own money. It can be seen that some money loaned has a very fast turnover rate.

In almost all cases the interest rate is 8%. Credit is one subject which all ranchers would discuss generally, but when questioned specifically about the total sum of money they had on loan they would answer evasively. The assumption that each rancher had fifty colones per animal on loan for the Size C and D ranches is probably not too inaccurate. For engordadoras, this figure would be at least double. It must be emphasized that many ranches with excellent credit potential, do not assume loans as a matter of personal preference. Annual cost of credit (VT) would be for

Size C VT = ₡1,200

Size D VT = ₡4,000.

Summary of Breeding Herds Cost Basis

In order to incorporate the breeding herd into the fixed capital investment(F) and the operating cost (V) formulas which have already been developed for land values and pasture, the herd composition for each size category was taken to be that of Table IV. However, only bulls, cows, and vaquillas are a legitimate capital investment. The other categories of animals, while incorporated into the operating cost formula, are benefits, or respectively, calves (Output I), novillos (Output II), and toretes (Output III). The composition of the herd on which capital investment is computed is:

$H = B + C + Q$ where

H = herd composition,

B = number of bulls,

C = number of cows,

Q = number of vaquillas

Transferring statistics from Table IV:

Size A $H = 1 + 8 + 1 = 10$

Size B H = 2 + 27 + 12 = 40

Size C H = 5 + 181 + 49 = 235

Size D H = 19 + 526 + 63 = 608

This is the herd composition to be used to determine fixed capital investment as it represents the average condition and production of criador ranches in Guanacaste.

For those ranches which have only criador functions, and there are many such ranches, the following formula based on bull cow and vaquilla:cow ratio gives:

Size A H = 1 + 8 + 1 = 10

Size B H = 2 + 34 + 14 = 50

Size C H = 6 + 230 + 64 = 300

Size D H = 31 + 868 + 101 = 1,000

The fixed capital investments (F) are given in the following five categories:

1) Present Herd Value

$$PH = Bp + Be + Br + Bc + Cp + Ce + Cr + Cc + Vp + Ve + Vr + Vc \text{ where}$$

B, C, and V are as defined above,

p = purebred value,

e = encastada value,

r = enrazada value, and

c = criolla value.

Substituting actual numbers and values in colones,

$$\begin{aligned}\text{Size A } PH = {} & \left[0(8000) + 0(3000) + 0(1700) + 1(800)\right] + \\ & \left[0(5500) + 0(2000) + 0(1000) + 8(650)\right] + \\ & \left[0(4500) + 0(1600) + 0(600) + 1(450)\right] = \\ & 800 + 5200 + 450 = ₡6{,}450\end{aligned}$$

Size B FH = [0(8000) + 0(3000) + 1(1700) + 1(800)] +
[0(5500) + 0(2000) + 15(1000) + 12(650)] +
[0(4500) + 0(1600) + 9(600) + 3(450)] =
2500 + 22800 + 6750 = £32,050

Size C FH = [2(8000) + 2(3000) + 1(1700) + 0(800)] +
[1(5500) + 11(2000) + 120(1000) + 49(650)] +
[1(4500) + 8(1800) + 40(600) + 0(450)] =
23700 + 179350 + 41100 = £262,150

Size D FH = [6(8000) + 10(3000) + 2(1700) + 1(800)] +
[20(5500) + 100(2000) + 380(1000) + 26(650)] +
[16(4500) + 47(1600) + 0(600) + 0(450)] =
82200 + 706900 + 147200 = £936,300

2) Costs to Improve Herd, Internally Derived

The costs involve changes in the quality of the herd based on a stable population and the assumption that herd quality is being upgraded as fast as possible. The actual investment cost is the difference in price between the animal being introduced into the herd and the price of the animal being sold. These are opportunity costs, as the rancher could make the choice that he would sell the better animal and retain the poorer one. Where there is no change in breed cross, it is assumed that there is no change in value. In fact there is some increase in value when an animal which is still breeding is replaced by a better quality animal, but in most cases a sterile animal is the one replaced.

Changes in quality were found to follow a general pattern in value. The best quality animal would, in effect, replace the worst. For example, a new purebred would replace a criollo if there was still one on the ranch, second choice for replacement would be an cruzado, then an encastado. Under the most accelerated conditions and using the above composition of herd size and calf cow ratios, the following pattern would occur. This rapid upgrading of the herd, and the accelerated process of spatial spread of animal crosses, probably takes place much slower than it appears. Many ranches in all size categories are at a much lower position in the herd improvement spiral than the theoretical composite used here.

Fixed capital increases due to internally derived herd quality (FHI) become:

Size A FHI = £0

Size B FHI = £2,400

Size C FHI = £34,000

Size D FHI = £171,000

3) Costs to Improve Herd, Externally Derived

Ranchers have a limited program of improving their herd by buying animals, primarily bulls, from other ranches. These costs are compiled the same as for FHI, so fixed capital increases due to externally derived herd quality (FHE) become:

Size A FHE = £0

Size B FHE = £1,300

Size C FHE = £5,000

Size D FHE = £14,000

4) Costs to Increase Herd Size

There is also an additional investment when herd size is increased. As mentioned before, a few Size D ranches are the only established ranches which are expanding herd quantities to a considerable degree, roughly by five encastado bulls and 195 enrazado cows. There are ranches in other size categories which are building up their herd size rapidly. The value due to quantity increase (FHG) becomes

Size D = £210,000

As herd increases are extremely variable, with many Size D ranches having stable herd sizes, this fixed cost will not be computed in the fixed capital formula.

5) Costs to Replace Mortality Losses

As mentioned before, the breeding herd mortality rate is approximately 5% Given this percentage and the herd compositon as given before, costs to replace mortality losses (HVH) becomes

Size A FHM = £325

Size B FHM = £2,000

Size C FHM = £9,750

Size D FHM = £42,950

Operating costs as they pertain to animals (VHO) are only a small part of total operating costs on the ranch. Using the following formula

VHO = AK + AT + AD + AG + L + AM where

A = number of animals,

K = vitamin A shots for purebreds only,

T = pregnancy tests,

D = control of internal parasites and diseases,

G = control of external insects,

L = total labor costs pertaining to animals,

W = interest charges on borrowed capital, and

M = value of Outputs II and III who died.

Substituting actual values in column

VHO = A(8) + A(3) + A(4) + A(4) + L + A(1000) and for

Size A VHO = 0 + 0 + 10(4) + 10(4) + 100 + 0 = £180

Size B VHO = 0 + 0 + 50(4) + 50(4) + 500 + 0.1(1000) = £1,000

Size C VHO = 0 + 0 + 300(4) + 300(4) + 5200 + 0.6(1000) = £8200

Size D VHO = 28(8) + 500(3) + 1000(4) + 1000(4) + 14000 + 1000(4) + 3(1000) = £26,724

Outputs I and III of Breeder Ranches

As soon as the rancher decides that a particular animal is not to be incorporated into his own ranch's production function, that animal becomes an output rather than part of his capital investment. That animal continues to consume valuable space and labor however, thus these costs have been computed into the costs for the breeding herd in general.

The annual output of calves can be computed by using the formula

Output I = ADJK where

A = number of breeding cows,

D = calf cow ratios under optimum conditions,

J = constant to adjust to annual basis, and

K = constant to adjust for the mortality rate of calves.

Substituting actual values

Size A Output I = 8(.6)(.8)(.95) = 3.6

Size B Output II = 27(.7)(.8)(.95) = 14.4

Size C Output III = 181(.8)(.8)(.95) = 110.0

Size C Output IV = 526(.85)(.8)(.95) = 340.0

Output I (calves) are rather obscure animals in terms of economics, until they are weaned. At that time the rancher decides for the males whether an animal becomes a novillo (Output II) or will be used for breeding (toretes). The decision about females is often delayed until just prior to salable age. She is either sold, sometimes pregnant, for slaughter or retained for breeding. Vaquillas can be sold much earlier of course where the ranch is limited by the dry season in carrying capacity, and some ranchers have a fixed policy of selling them just after weaning. As mentioned before, vaquillas are not considered Output III unless they are sold for breeding outside the ranch, which seldom occurs.

Toretes are young bulls which are considered good enough to serve as breeding animals. Almost the entire male offspring of purebred herds is designated for this purpose. If the ranch is large enough, the demand is entirely internal as ranchers replace animals with less Brahman blood. A few ranchers must sell these to avoid conflicts in breeding lines. In most cases they trade toretes, with a small cash adjustment based on differences in quality, with other ranches in a similar position. In these cases trade is often conducted with areas outside of Guanacaste to introduce entirely new bloodlines. Large ranches usually do not keep non-purebred animals for breeding purposes, because they consider it not worthwhile. They prefer to buy a purebred from the specialized breeding ranches if they are not able to meet their own demand for breeding bulls. If an individual requests purchase of a specific animal, then it will be sold as a breeding animal. These large ranchers who still depend somewhat as criollo bulls are the main exception to this pattern. They often keep the better encastado and even enrazado animals and place them on the open range to breed. As mentioned earlier the criollo bulls are culled out as part Brahman animals increase in number.

Size A and B ranches very seldom keep toretes. They may keep one or two in order to trade with other ranchers to avoid crossing bloodlines. But Size B ranchers seek breeding bulls primarily from the Size C ranchers who have enrazado and encastado animals. This demand, and the demand from other Size C ranches, is the reason for the high percentage of toretes shown on Table IV. Even so, under one-third of the ranchers take the trouble to raise toretes for sale. As herds get a higher and higher proportion of Brahman blood, there is a corresponding positive tendency to produce breeding animals for sale, and a higher proportion of animals designated to be sold for breeding rather than slaughter. In no case was more than 50% of male offspring held for breeding purposes.

The advantage of having breeding animals for sale is to be found in the market prices given earlier. The disadvantages are much more numerous. These animals need special care, having to be separated from other animals and even in some cases from each other. They are usually not sold until their second year, thus occupying space required for a breeding animal. This can be a major deciding factor against toretes for those ranches which are already over-extended and poorly prepared to cope with the dry season.

Novillos (Output II)

All discussion on novillos existing on both criador and engordadero ranches has been consolidated here. Most variables have already been mentioned: that the mortality rate is lower, labor costs lower, capital interest costs higher, and so on.

Both toretes and novillos are responsible for one necessary adjustment in constructing the cost formula for pastures. The assumption that one manzana can support one animal is not true for toretes and novillos. One manzana can support only 0.8 of these animals, a figure indicated before but discounted until now. As the number of these animals is now known on criador ranches, the following formula can be used to calculate the increased pasture requirements (IPR):

IPR = 1.25(number of novillos plus number of toretes)

Substituting actual numbers:

Size A IPR = 1.25(0) = 0 manzanas

Size B IPR = 1.25(9 + 0) = 2 manzanas

Size C IPR = 1.25(48 + 17) = 16 manzanas

Size D IPR = 1.25(376 + 16) = 98 manzanas

The final fixed (F) and operating costs (V) due to IPR, assuming only Jaragua and only pasture land use added, are :

Size A FIPR = ¢0, VIPR = ¢0

Size B FIPR = ¢1,100, VIPR = ¢130

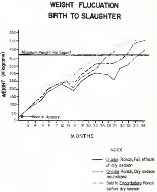
Size C FIPR = ¢8,800, VIPR = ¢720

Size D FIPR = ¢48,400, VIPR = ¢6,880

Engordadero ranches are very seldom smaller than one hundred head, and they tend toward largeness in area. Two ranches, one in the Rio Tempisque floodplain (Region IB) and the other in Region IV, handle over 10,000 head a year.

Engordaderos tend to specialize even among themselves. The smaller ranches are located in drier parts of Guanacaste and buy mainly from their immediate neighborhood. Often, they do not hold the animal to marketable weight, but sell it to one of the large engordadero ranches for final fattening. These large ranchers are provincial in their buying patterns. This is where maximum gains per day can be achieved. Fertilization is something often practised to increase protein count, pasture rotations are rapid, concentrates and minerals are given, and hormone shots, a recent innovation, are used to induce more rapid weight gains. These large engordaderos may have the animal for only the final six months. Another change is that these ranchers are now willing to pay slightly higher prices for young bulls, causing a gradual end to castration. While there are increased costs of handling, there are also increased gains, as a young bull, equivalent to a young novillo in quality and age, will weigh at least fifty kilograms more at market.

The following figure indicates how weight is gained by the average entrada novillo. Animals on criador ranches which have no bajuras or extensive forests, and which undertake no supplemental feeding programs, suffer great weight losses. If born in January, the mother's milk will carry the animal over, but at a slow weight gain. During the second and third dry season, the animals can lose



WEIGHT FLUCUATION
BIRTH TO SLAUGHTER

Figure 10

over fifty kilograms each dry season. Fortunately, the animal is able to regain weight very rapidly until he reaches normal weight as dictated by bone size, then he gains at a slower pace. If he has not reached marketable weight prior to the beginning of the fourth dry season, he is usually sold to an engordadero for final fattening.

If the rancher has adequate bajuras and undertakes supplemental feeding programs, the animal's weight can be maintained. Two and a half years are still required to obtain a marketable animal. He may sell the animal any time after thirty months, but invariably sells prior to the next dry season. When the animal is sold to an engordadero prior to the second dry season, some weight loss is avoided. The third dry season sees the animal on supplemental feeds and hormones and weight gains continue to occur until market date.

The fourth line on the figure gives weight gains for a small group of Brahman animals.[58] Note especially the higher initial birth weight (birth data not given) and the more rapid initial gain. The effect of one dry season is seen where weights stabilize around 220 kilograms, but thereafter weights increased constantly. The fact that these animals are only marginally ahead of novillos on engordadero ranches casts some doubt on how much Brahman an animal really needs if he is destined for slaughter. Upgrading is needed, as criollo novillos take much longer to reach minimum weight for export, if indeed they reach it at all.

The Brahman line on the chart indicates another factor on which there is insufficient research under Guanacaste's environment.

There is a certain point at which gains decrease. For the Brahman it is around 475 kilograms. Ranchers vary in their opinion as to what is an optimum market weight, with responses ranging from 450 kilograms to 500 kilograms.

The actual prices the engordadero rancher pays for these animals is mainly a consideration of the marketing system and will be dealt with in Chapter III

Special Purebred Criador Ranches (Output III)

Most of the factors discussed for the average criador ranches are applicable for these specialized ranches as well. All inputs are more intensive however. There is a higher incidence of improved grass species, high capital investments in the form of buildings, a high degree of mechanization, labor is more skilled and consequently higher paid, health measures are better, and there is often a succession of loans to buy and import new breeding stock

The cost figures on the value of purebreds are applicable here, but again quality is higher than average. Their outputs are, of course, the inputs on other ranches. These specialized ranches not only sell in Guanacaste, but also to the rest of Costa Rica and to countries from Guatemala to Venezuela.

As there are only five of these ranches in Guanacaste, it is difficult to deal with averages, thus no attempt will be made to construct a cost-benefit formula for them. They are very prosperous however.

The basic breeding herd numbers around four hundred purebred Brahmans, and toretes and vaquillas are present in even greater numbers None of these ranches produce animals for slaughter All have expanded their purebred producing program to the point where they no longer need all the vaquillas produced for themselves. They have recently started to sell vaquillas to other ranchers in Guanacaste, a trend which will upgrade the herds even faster than they are at present being upgraded.

The procedure of selling takes several different forms. In most cases the buyer will visit the majority of these ranches before a final transaction is concluded. He may be shopping around for the best deal or the best animal, but he may be looking for a specific bloodline or a specific type of animal. When the desire for a bloodline is great, the buyer may put in his order several months or even years before an offspring is produced This is especially true of these transactions which occur between the specialized purebred breeders themselves

One of the activities vitally important to purebred ranches is the annual cattle exposition which is held in Liberia every year. Other expositions occur in other parts of Costa Rica as well The ranchers compete with each other for categories such as grand champion bull and grand champion cow, and the owners of the winners of these categories has his reputation as a good breeder enhanced considerably. Winning also pays dividends in monetary terms as well, as winning animals can be sold for very high prices. A large number of sales actually do take place at these expositions.

There is also a Cental American exposition held every year. In 1969, this was held in Costa Rica, and all Central American countries participated A win in these international expositions is even more prestigious. There is a significant amount of bloodline crossing between countries as sales do take place here to a considerable extent

NOTES

1. Herd size was thought to be a better variable upon which to categorize the ranches rather than using ranch size in terms of manzanas. A high manzana figure could hide a relatively small operation and vice versa.

2. The base map for this map and subsequent maps of Guanacaste is derived from Mapa de la Provincia de Guanacaste y Zonas Adyacentes, prepared by the Instituto Geográfico de Costa Rica, 1957, at a scale of 1:250,000. The content of the map with regard to landforms is derived from field observation, Plath, C.V., Uso Potential de la Tierra, Parte V Istmos Centroamericano, Food and Agricultural Organization (FAO), Roma, 1965, and Castro, J.J., Planificación del Uso de la Tierra, Peninsula de Nicoya, Costa Rica, Instituto Interamericano de Ciencias Agricolas de la OEA, Turrialba, 1968.

3. Castro, J.J., Planificación, 1968, p.60.

4. Ibid., p.60

5. Plath, C.V., Uso Potential, 1965

6. Castro, J.J., Planificación, 1968, p.60.

7. Ibid., p.60.

8. This area offers one of the best hopes for developing Costa Rica as a net exporter rather than a net importer of rice. Potential has been barely tapped at present. There are a great number of small rice producing areas scattered throughout the Nicoya Peninsula, but they are mostly orientated toward local consumption. For example, there are seventeen rice mills employing thirty-seven people. Tirado Salazar, F., and Nuñez, M.A., Datos Generales, Introducción a los Inventarios e Inventario de los Recursos Naturales de la Peninsula de Nicoya, Asociación Regional para el Desarrollo de la Peninsula de Nicoya, Nicoya, 1965, p. 160.

9. The main crops are rice, corn, beans, and bananas. For a discussion on these, see Alfaro, G., Problemas que Afectan el Desarrollo Agropecuario en Cuatro Cantones de la Peninsula de Nicoya, MAG, San José, 1966.

10. See Budowski, G., Inventario de los Recursos Forestales de la Peninsula de Nicoya, Asociación Regional para el Desarrollo de la Peninsula de Nicoya, Nicoya, 1967

11. The colon is on a fluctuating exchange rate. From July, 1968, to April, 1969, it went from ¢7.82 to ¢6.92 per United States dollar.

12. The best discussion on the dry season, and the classification of different types of dry season is found in Coto Aguilar, J.A., *Diagnóstico y Recomendaciones para el Planeamiento del Desarrollo Agropecuario de la Península de Nicoya*, Universidad de Costa Rica, San José, 1968.

13. Climatic figures are for the period 1956 to 1965 for rainfall, and 1966 for temperature. The temperature for Liberia was not given so the figures from Filadelfia were substituted.

14. Tirado Solano, F., and Muñoz, M.A., *Datos Generales*, 1965, pp. 65-66. The remaining 5% is subdivided between areas subject to flooding and salinization areas. Some of these could be used if adequate drainage was provided.

15. Taking an average of ¢8 per day per worker, this would range from twelve to twenty-four days clearing. This compares quite well with the nineteen day clearing time found in Darien, Panamá. Figures for Darien taken from Smith, V.A., *Rural Economic Activity in the La Palma Area of Panamá: An Analysis of Three Ethnic Groups*, M.A. Thesis, University of Florida, Gainesville, 1967, p.99.

16. Construction costs are substantially less in Guanacaste than they are for Anglo-America. Average cost of a modern house is around $6.00 per square foot. There are local lumber mills in Puntarenas province which supply lumber, as well as several very small lumber firms in the Nicoya Peninsula.

17. Figures obtained from various ranchers and from the Banco Central de Costa Rica. The repayment period for various types of infrastructure is normally eight years. Banco Central de Costa Rica, *Reglamento de Crédito Uniforme para Ganado Vacuno*, Banco Central de Costa Rica, San José, 1967, p. 135.

18. Acuña states that Jaragua was first introduced in 1928, and that it invaded all types of vegetation. There was a superstition at first among the ranchers that Jaragua caused Catarecto in cattle. Acuña Acevedo, M., *Informe Sobre la Industria Ganadera y Pastos en la Zona de Guanacaste*, M.A. Thesis, Universidad de Costa Rica, San José, 1936.

19. MAG, *Cultivo de Pastos en Costa Rica. Manual de Recomendaciones*, Boletín Técnico No. 51, MAG, San José, 1966, p. 51. This booklet is a very good compendium of the characteristics and method of obtaining maximum growth from the various types of pastures found in Costa Rica. It would be invaluable to ranchers, but unfortunately it has very limited distribution and is practically useless in its present locations.

20. Ibid., p. 22.

21. Kretschmer, A.E., Jr., 'Proposed Pasture Improvement Program Using Tropical Legumes and Grasses," University of Florida Report, San José, 1968, p. 9. See also Kretschmer, A.E., Jr., "Programa Cooperativo Ministerio de Agricultura - Universidad de Florida, Para El Estudio y Desarrollo Practico de Leguminosas, Como Mejoradores de los Recursos Forrajeros de Costa Rica," Unpublished manuscript, San José, 1968.

22. ITCO was established in 1962 by Law Number 3042. Its objectives are to create a fair distribution of land in Costa Rica, incorporate the small agriculturalists into the national economy, and avoid land exploitation speculation detrimental to the national society.

23. MAG, Memoria, 1967, MAG, San José, 1968, p. 43.

24. The following quote is relevant. 'It is well known that intensive pasture use during a short time, with a long rest period (of some twenty-five days) after is preferable and results in a doubling of production per unit.' Manger, S.G., Investigación Sobre la Rentabilidad Económica de la Producción Bovina en Diversas Zonas de Centroamerica, Unpublished manuscript, Guatemala City, 1967.

25. MAG, Cultivo de Pastos, 1966, p. 52.

26. Blue, W.G., Fertilizando los Pastos Tropicales, Centro Agrícola Tropical, Universidad de Florida, Monografía II, Gainesville, 1965, p. 7.

27. This experiment was carried out in October 1967, using pure nitrogen. MAG, Memoria, 1968, p. 115.

28. Ibid., p. 116.

29. Ibid., p. 116.

30. Blue, W.G., Fertilization Experiments, 1960, p. 86.

31. Ibid., p. 12.

32. MAG, Memoria, 1968, p. 115.

33. Ferrica, Las Siete Vacas Gordas, Fertica, San José, 1968.

34. An experiment done on guineo in the Nicoya Peninsula gave the protein percentage of platanos as 16.66 and of bananas as 4.94. Distribuidora S.A., Unpublished manuscript, San José, 1968, p. 1.

35 A haying experiment was conducted at the agricultural college in Liberia in 1967. The following costs were listed:

Equipment (from mower to dryer)	¢90,700.00
Depreciation of equipment	15,116.65
Drying racks and plastic	976.00
Depreciation of racks	325.33
Operating costs (based on 3,000 bales)	1,848.74
Total per forty-five pound bale	1.65

Estudio Económico de la Producción de Heno, Unpublished paper, San José, 1967, pp. 1-2

36 Ibid., p. 2

37. MAG, Situación Actual, 1969, p. 1.

38. Acuña Acevedo, N., Informe Sobre la Industria Ganadera, 1936

39. The 1968 figures are preliminary, 1969 figures are estimates. There is some discrepancy in the figures.

40 Oficina de Planificación y Banco Central de Costa Rica, Plan Para Fomento de la Ganadería de Carne, San José, 1965, p. 10

41 Ibid., p. 11

42. Unpublished figures from MAG, 1969

43 Ibid.

44. Ranchers are exposed to pamphlets such as "Su Futuro con el Ganado Charolais" printed by the American International Charolais Association, Houston.

45 Unpublished figures from MAG, 1969

46. Alba, T., Reproducción Genetica Animal, Instituto Interamericano de Ciencias Agricolas de la O.E.A., Turrialba, Costa Rica, 1964, p. 93

47 Grillo, H.A., "Manejo del Ganado de Carne," El Agricultor Costarricense, Vol. XXV, No. 6, pp. 195-198.

48 Ley Numero 1207 de Octubre de 1950, MAG, San José, 1950

49. Decreto Numero 1 de 29 de Enero de 1958, MAG, San José, 1958

50. For a brief resume of various diseases, see "Resumen de Algunas de las Enfermedades Infecciosas y Parasitarias mas Comunas en el Ganado de Panamá," Unpublished manuscript, Ministerio de Agricultura, Comercio e Industrias, Panama City, 1968.

51. The leading article in *La Nación* of September 11, 1966, was "Danger of Foot and Mouth Disease - Nicaragua closes its Frontier with Costa Rica." It was thought the disease entered Costa Rica from ships carrying livestock to and from Peru. The scare was a false alarm however, and Central America continues to be free of this disease. See also Bulletin Number 7 from the Departamento de Sanidad Animal, MAG, for regulations protecting against foot and mouth disease.

52. In 1968, there were only seventeen veterinarians employed by the government for all of Costa Rica, in 1969 this figure had dropped to fourteen. Oficina de Planificación, *Dirección y Sub-Dirección General de Servicios Agropecuarios, Programa 1 05 Servicios Ganaderos*, Unpublished manuscript, 1969, p. 24.

53. Briceno, R. and Herrera, S., *Derrengue Toxico Bovino* (*Mal de Bribe*), *Nota Previa*, La Camara de Ganaderos de Guanacaste, San José, 1967.

54. El Comite Coordinador del Grupo de Expertos Nacionales, *El Crédito Agrícola en Costa Rica*, Revised Edition, Banco Central de Costa Rica, San José, 1966.

55. Banco Nacional de Costa Rica, *Monografia del Crédito Agropecuario en Costa Rica*, Unpublished manuscript, Banco Nacional de Costa Rica, San José 1968. Hunting and fishing loans are inconsequential.

56. Banco Central de Costa Rica, *Reglamento de Crédito*, 1967.

57. Banco Central de Costa Rica, *Crédito y Cuentas Monetarias*, Monthly Report, San José, December, 1968.

58. MAG, *Situación Actual*, 1969, p. 61.

THE MARKETING SYSTEM

Introductory Remarks

The preceding chapter has explained the production function of the various ranch sizes in Guanacaste. Resources, both internal and derived from outside the ranch, vary a great deal from region to region and from one ranch size to another. The utilization of these resources is determined by the decisions of the individual rancher. While he may be able to change his production function a great deal, based on cost data or other considerations, the market cannot be altered by the rancher acting as an individual. The cost structure and the production of ranches has already been established; the benefits are determined by market considerations and the situation of the rancher to the various marketing channels and services. This, then, becomes the concern of this chapter.

Fortunately, the marketing system is not as intrinsically complicated as the production function. Regardless what production function the rancher uses to minimize cost or increase productivity, ranchers consistently demand that marketing costs be minimized and prices paid for their output be maximized. Because an open market does exist in Guanacaste, it tends to gravitate toward these demands, recognizing that ultimate limitations are placed on price by consumption. In an area the size of Guanacaste however, there are differences in accessibility, climate, availability of middlemen, etcetera, these variations mean that ranchers have different marketing possibilities. Within limits imposed by supply and demand, the market does function to the rancher's satisfaction in some areas. In others, the market channels are so long and complicated that even efficient ranchers have little hope of success.

Besides regional variations, the position the rancher has in the market system depends upon his ranch size and the nature of his output. These two factors have been thoroughly analysed for the production function, but the market implications need to be examined further. For purposes of this chapter, Output III has already been sufficiently discussed in terms of regional variation and location, quantity, quality and price phenomena. There is one other output which has been implicit in the foregoing discussion, but which has not been discussed as a market phenomenon. These animals within the breeding herd which are no longer suitable for breeding are sold for slaughter. For purposes of analysis, bulls are treated as Output II because marketing practices are generally the same as for novillas, except for price variables. Cows are marketed with sufficient distinction that they are considered a separate output, and are designated Output IV.

One other output which all criador ranches have is dairy products (Output V). While the return may be insignificant for large ranches, decreasing size of ranch means greater and greater significance for this product. The milking of Brahman and criollo cows is the main reason for having animals in many minifundia situations.

Before the analysis of the marketing system in Guanacaste begins, a look at the following figure is in order. This gives the total extraction of animals in an historical perspective, but just as important, the flow of animals by Outpost I, II, and IV destined for slaughter is demonstrated. In terms of percentage, the total annual extraction gains are slightly ahead of gains in herd increases. This is due to the increasing influence which non-Guanacaste areas have, as their extraction/herd ratios are higher because they do not have to contend with the dry season. But even Guanacaste is improving the extraction/herd ratio (from 1:7.5 in 1954-1955 to 1:7.3 in 1968-1969) as regional specialization occurs and measures to combat the dry season are introduced.[1] The ratios for cows would be slightly lower because of the rapid increase in herd quality. Very few calves are extracted for slaughter in Guanacaste; these almost entirely originate in the Meseta Central areas.

The following analysis will be organized around the factors of isolation as they affect the various middlemen and marketing channels as found in Guanacaste. While full discussion on transportation will be included later, an impression of accessibility can be obtained by previewing Figure 12, the map on road networks.

Middlemen and Marketing Channels

Minorista Pequeño

The minorista pequeño is a perfect example of how a small middleman can survive easy under conditions of extreme isolation and upon ranchers too small to have any market options. His location is typically found in the small, isolated settlement clusters of the

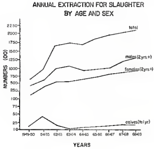

ANNUAL EXTRACTION FOR SLAUGHTER
BY AGE AND SEX
total
males(2yrs.+)
females(2yrs.+)
calves(to 1 yr.)
NUMBERS (00)
2250
2000
1750
1500
1250
1000
750
500
250
100
75
50
25
10
1949-50
54-55
62-63
63-64
64-65
65-66
66-67
67-68
68-69
YEARS

Figure 11

southern Nicoya Peninsula and in isolated hamlets north and east of Liberia and Bagaces. He buys from ranchers only within his immediate neighborhood, rarely travelling more than two or three hours on horseback in any one direction. This does put him into competition with other minoristas however, and areas immediately adjacent to his own home are not secure from encroachment by his competitors.

The market function he performs is highly stylized and shows almost no variation from one minorista pequeño to the next. His market information is based on rumors or on requests from ranchers who want to sell. In many cases he can anticipate a sale because he knows that a certain family is in financial trouble. Once he is aware of the possibility of a sale, he will ride out, view the animal, and make an offer. The minorista often buys only one or two animals a day and averages under ten a week. Many weeks throughout the year he buys nothing at all.

The majority of the ranchers he buys from are Size A who are unwilling to travel to a larger town to market the animal themselves. If the rancher is lucky and has sufficient land, he may be able to keep a novillo for a year or two. In most cases, however, the animal is at an early age, just after weaning or before the dry season. Sterile breeding stock is also sold to the minorista from time to time. The minorista may buy from Size B ranchers, as they have a tendency to sell non-breeding females one at a time. Larger ranchers usually sell in lots, and thus attract middlemen with more capital.

Once the animal is bought, it is herded or led back to a small holding pasture near the minorista's house. He could very well be a Size A or B rancher himself, in which case the animal is placed with his own herd. The minorista has a very rapid turnover of animals, sometimes selling them the next day but more often selling cattle on a Friday or Saturday

The profits the minorista makes are very marginal. He actually loses on some animals due to misjudgement of market conditions and because he cannot afford to keep the animals more than a short time The average gain per head is only around £15 which means that in energy expended the minorista makes little more than a peon

The intensive competition for animals is not based as much monetary considerations as it is on the ability to make the first offer A rancher can show his animal to several minoristas, or can take it to a larger town such as Jicaral, Hojancha or even Nicoya or Liberia This competition means that prices are only marginally lower on the ranch than in town It also means that it is almost impossible for the minorista to build up any capital reserves Thus, while the seller may show his animal to several minoristas, the difference in prices he is offered is only £10 to £15

Minorista Grande

In spite of the competition, and the low quality and numbers of animals bought, a few minoristas do make substantial profits When they have amassed considerable amounts of capital they assume the functions of a minorista grande Or, in many cases, his son does. Such middlemen also have certain typical characteristics; they live in towns like Lepanto, Garza, or even Nicoya where urban functions such as stores and restaurants exist, they are more numerous in the Nicoya Peninsula towns than elsewhere, but they are found throughout Guanacaste

The trading area of each individual is often very extensive He can ride two or three days over well defined routes, buying animals as he goes. On returning he collects these animals and herds them to holding pastures near town. This often requires a helper, who is paid at peon wages. Each einerista grande may have three or four of these routes If he operates out of towns in southern Nicoya, the routes tend to be elongated in a north-south direction, out of towns in other parts of Guanacaste routes tend to be more circular, sweeping in nature. In both cases, the path is highly irregular, as the einerista visits the greatest number of ranches and hamlets with a minimum of distance

Competition between this type of middleman can be great in some regions, but with isolation competition becomes less and less In some regions, one einerista grande is the only market link available. In these cases prices are marginally lower, but the seller always has the option of driving his animals to a larger town where there is competition

Besides location and routes, another major distinguishing feature between the einerista grande and pequeño is that the former prefer to buy in lots rather than individual animals Large Size A and B ranchers and eineristas pequeñas sell to this middleman. If an individual animal needs to be sold, the einerista grande will buy only if he does not have to deviate more than a couple of hours from his route. Buying in lots on his two trips a week allows him to handle up to fifty animals per week. Like the minorista pequeño, there are many weeks when he does not buy at all. This is especially common during the first few months of the rainy season, as ranchers have sufficient pasture and are waiting to make sure that a breeding animal really is sterile.

Minoristas grandes buy all types of animals, calves, novillos, bulls, and cows. A few ranchers make a crude kind of white cheese, in some cases this is also bought and sold in the larger towns. A few cows are bought on Size C ranches.

They are dealing with Size B ranches who have animals with some Brahman blood, a situation in which opinions vary greatly as to the quality of the animals to be sold. Criollo animals do not vary much in quality and have only a small range in price. Variation in quality of mixed blood creates heated discussions regarding price. It seems almost impossible to establish sale price because the minorista grande versus the rancher and the minorista pequeño are arguing from two different viewpoints. The latter two regard the animal as a unit indivisable because, after all, they are working constantly with these units. The minorista grande always thinks of the animal in terms of kilograms because that determines the value of the animal when he sells it. The minorista grande can also list the various marketing costs which he has, but the rancher often refuses to grant him these costs.

It is atthis point that the establishment of regular clientele along routes becomes as important to the minorista grande. Years of mutual trading means that the buyer-seller communication is easy and quick. Some middlemen say it takes up to ten years before a smooth, functional relationship is worked out between the producer on the one hand and the buyer on the other. A person living within the trading area of a minorista grande can successfully challenge him for dominance; an outsider very rarely succeeds.

Travelling a wider region, and living in larger towns where he has more face-to-face contact with people, the minorista grande is more aware of what market prices are in San José. He can and does take losses on animals, but with less frequency than a minorista pequeno. He can hold animals for a longer period of time as well, as he usually has substantial pasture acreage in reserve. All these factors mean he can pay a little higher price to sellers, to be competitive if need be. A better selling posture however, allows this better price to be passed on to the next buyer. In general he makes an average of ¢15 per animal, but a large market base means that this man can be quite prosperous by Guanacaste's standards.

There was much discussion within Costa Rica that both types of minoristas are very detrimental to the cattle industry and should be driven out of business.[2] The best way to do this, based on empirical evidence would be to expand transportation facilities. Very few minoristas live along roads, and those who do have had to work much harder just to maintain the economic well-being they had before the road was there. The objective which people hope will occur with the elimination of this level of middlemen would be that the small rancher can then deal directly with the retailer or engordadore. In actual fact, even in areas of good accessibility, the small rancher depends upon middlemen and receives only insignificantly higher prices.

The minoristas are very essential to many small ranchers because they provide place utility. Theirs is a collecting operation essentially, bringing animals together into a lot large enough to attract the attention of large scale middlemen (comerciantes) or engordaderos who often desire truckloads of animals at one time. It is these large operators who really determine the price to be paid in Guanacaste, as they are the ones subjected to the prices offered in the Meseta Central. In most cases, if the minoristas were not there, the small rancher would be worse off. To make it profitable for the large operator to come to his ranch, the small rancher would have to sell his animals at an extremely low price. Even low prices would not induce the comerciante or engordadero to penetrate those interior parts of Guanacaste which cannot be reached by jeep or truck.

One other alternative which the small Size A or B rancher has is to market the animals himself. The rancher can often retain for himself the money represented by the minorista's profits even if the animals pass through the hands of both the minorista pequeno and grande. There are definite disadvantages in direct sale however. The rancher loses at least a day in the marketing process which could be spent working for wages, or on his own food crops, or in some other productive activity. Ranchers at the southern end of the Nicoya Peninsula often find marketing a two day process. Combining his selling with his own shopping, as the trip will take him to large towns such as Nicoya, Liberia, or Las Juntas, in part compensates for his effort if he is prudent. But once the seller has made his sale in town he may spend the money on unnecessary items, which would not have been possible had the minorista paid him the money on his ranch.

There is also the problem of communication as mentioned before. The rancher may not know anyone in the business of buying, at least the first time he tries marketing himself. In this case the seller can find a business transaction terribly cold and impersonal. At least the minorista grande brings the local and national news with him, a commodity of some importance in the isolated settlements of Nicoya. The seller is generally dissatisfied with the 'business transaction', not because it is unfair in terms of money, but because the seller lacks a personal feeling of accomplishment. When selling to a minorista the rancher feels he has bettered the buyer in the deal; when selling to a strange comerciante or engordadero, the seller invariably feels he has come out the loser. This, in the final analysis, may be the true reason why care is needed if market manipulation becomes merely a tool to drive the minorista out of business.

Comisionista

The comisionista is a product of good accessibility. Originally a minorista grande or small comerciante, he was forced out of business by middlemen operating on high volume, low profit turnover. Unable to participate in buying and selling, he in effect charges a finders fee of 5% of the final sales price to bring output and buyer together. This man is widely known and respected. He has developed near perfect communications with large numbers of ranchers and minoristas, and can converse with equal facility when determining final sales price with buyers. Because his service is highly specialized, only one comisionista is found in each of the large canton capitals. He is not found in Region IV, however, for the density of engordaderes willing to buy direct from criadores is too great here.

All the place utility functions of a minorista grande are provided by the comisionista. The small rancher, even with good accessibility, and the isolated minorista pequeno, avail themselves of the services of a comisionista. If the rancher has an animal for sale, he will notify the comisionista. The comisionista will make arrangements to pick up and deliver the animal, or the rancher can deliver the animal himself if he is coming to town anyway. Ranchers as large as Size C often avail themselves of a comisionista's services, at least for Output IV. The comisionista's holding pastures are invariably located just outside of town on an all-weather road.

These holding pastures are regular stopping places for people who are buying animals either for fattening or to take to the Meseta Central for slaughter. The comisionista does all the bargaining, either selling animals singly or in lots of animals of comparable quality. Even when the seller is there in person, he rarely interferes with this bargaining process. Several offers by different buyers are usually made before the comisionista decides on the best one. The comisionista is bargaining from strength, as Nicoya and Liberia are the locations where large numbers of trucks are loaded. The buyer is in or near town most of Friday and Saturday, the big marketing days. Thus most sales are finalized Friday evening or Saturday morning. A comisionista can misjudge the market price, but it is only rarely that he does not sell all animals. In any case he has sufficient pasture to carry the animals over to the next week. If he makes a better deal, he will sometimes charge a small fee for 'fattening' the animal, if not, then he gets his 5% only.

The comisionista performs an additional service for the minorista grande or large ranchers who want to sell in Guanacaste, who want to conduct and terminate their own bargaining and sale, and who are located in inaccessible parts of Guanacaste. Some ranchers near Nicoya and Liberia also engage in this service to some extent. The comisionista will rent his holding pastures for ¢1 per animal per day. Ranchers and minoristas grandes bring these animals in Thursday night or Friday morning, and sell them Friday or Saturday. The comisionista can make substantial profits on these operations. His pastures do not have to be good, and often are subjected to overgrazing.

The number of animals which the comisionista handles varies from week to week. Sometimes he will handle very few, other weeks he may earn a commission on over a hundred head, plus rent for his pasture. Costs are very low. All minoristas and comisionistas who operate primarily by horseback figure that costs average roughly ¢5 per head. A comisionista in Nicoya assembles some of his animals at Colonia Carmona, then hires a truck capable of hauling twenty novillos for ¢100 to bring the animals to Nicoya.

There is one other matter which had developed due to lack of accessibility. The small rancher or minorista, bringing animals from interior parts of Guanacaste to an all-weather road where they are then shipped by truck, needs to pay a loading fee. Many small corrals with loading chutes are scattered along all roads in Guanacaste. They are always found near the terminous of all roads, as for example, in Jicaral, Canjel, and Caimital and near towns such as Bagaces and Las Juntas. In large towns, such as Nicoya, the comisionista makes this service available. In other locations, facilities are made available by large ranchers who have built loading corrals for their own use.

A small fee of ₡1 is charged. Where there is provision for only loading, timing is very important. Both the animals and the truck need to be sure that the other is there at a specific time. The trucker often contacts several ranchers in an attempt to obtain full capacity at each loading location.

Mayorista and Local Consumption

The last alternative a small rancher has is to sell to a mayorista. In many respects this man is very similar to a minorista in that he buys only one or two animals at a time and the animals are almost invariably Output IV; he pays the same prices, and usually has a very small trading area which he traverses by horseback, or if he can afford it, by jeep.

He buys from ranch sizes A and B, and searches until he obtains the best price. Some mayoristas have their own ranches and obtain some animals from that. In addition, some mayoristas have arrangements to buy from relatives, but only if they can agree on the price.

Two very important differences separate the mayorista from the minorista. One, he is a product of towns, hence is not isolated.

And second, he actually processes and retails meat directly to the consumer.

Before discussing the retailing aspect of this particular middleman, the provincial consumption patterns need to be known. In 1966, there were 171,706 people living in Guanacaste.[3] The same year, roughly 6,000 head of cattle were slaughtered for local consumption.[4] Everytime an animal is slaughtered, a registration fee must be paid, so the above figure is probably fairly accurate, but a little low. Animals killed in isolated areas probably are not accounted for. Animals with broken legs, etcetera, also are killed and eaten by communities when they are found, and these are not counted.

Almost all animals consumed in Guanacaste are cows (Output IV) with an average gross weight of 350 kilograms and an average carcass weight of 50% of the gross weight.[5] Thus, consumption is only six kilograms per inhabitant per year in Guanacaste, and a certain proportion of that of course, is bone, suitable only for making soups.

There is a great difference in consumption by place and by income. It is seen that significant correlation between population and meat consumption is high only if families are taken as the basic unit of consumption rather than individuals. A large family will consume only slightly more beef than a small one, assuming the same income levels and location. Non agricultural families will spend ₡20 to ₡25 per week to buy beef. Prices, to be given below, indicate that this is just over a pound a day. This is true only in those towns which slaughter every day. As isolation increases and town size decreases consumption of meat goes down.

The large ranchers and a few of the top ranch administrators will buy from ¢10 to ¢15 per week. This stays fairly constant with isolation, as they are in town once or twice a week regardless of their location, and often buy all meat at the same time. Ranch size decrease means less income, fewer trips to town, and less consumption. A small Size A ranch family may consume two or three pounds of beef only three or four times a year. Agricultural laborers eat beef so seldom that they have not acquired a taste for it. Only those near town will buy one or two pounds a couple of times a year.

These consumption patterns and town size mean that the number of animals slaughtered varies a great deal from place to place. Liberia and Nicoya are the two primary centers of consumption, with an average of 135 and 95 animals slaughtered a month, respectively.[6] Liberia, the seat of Guanacaste's provincial government, is the center of higher education, and has distributive and retail functions that no other town has. Thus consumption is higher per family and a greater proportion of the population eat beef every day than in any other part of Guanacaste. Nicoya has many primary central place functions, as it serves all the Nicoya Peninsula; thus its population is large and economically prosperous.

The municipal slaughter house at Liberia averages six animals killed per day, the one in Nicoya averages four. On Saturday additional animals are killed as this is the day the country people come into town to make their purchases. The meat retailer (mayorista) has the option of selling on Sunday if he so desires in which case the animal is slaughtered on Saturday. Usually only those cuts which did not sell on Saturday are sold. Sometimes an additional animal is killed during the middle of the week as well.

Cañas exhibits strong central place tendencies and approximately three animals per day are slaughtered. Las Juntas, Tilarán, and Santa Cruz all slaughter two animals per day. The other four canton capitals only average one per day. All the above towns usually slaughter an extra animal on Saturday. In the smaller provincial capitals, sometimes three or four days pass with no beef available.

People in places like Santa Bárbara and La Cruz which have a small variety of urban functions find that their local mayorista slaughters and sells meat twice a week. Towns with very limited urban functions, such as Guayabo,Bolsón, and Villarreal often slaughter only on Saturdays.

The facilities for slaughter vary from place to place. Where there is multiple daily slaughter, the government has built a municipal slaughter house. Places slaughtering once a day often have poor facilities, and still smaller places practice open field slaughtering techniques.

The municipal slaughter house at Nicoya was chosen as representative of the former. The cattle bought by the mayoristas, one animal per man usually, are kept in a corral next to the slaughter house overnight without feed or water. Around four in the morning, one animal is brought into a squeeze chute, killed with a sledge hammer, and rolled through a moveable partition into the main slaughter room. This area is equipped with a tile floor, running water and a pulley affair with hooks on which to hang the meat. The cow is strung up by a hind leg using chains and pulleys, hit with a sledge hammer again, and bled into a bucket by plunging a knife into the heart. The animal is lowered, the central spinal cord is cut just behind the head, skinned by two men, and all extremities cut off. Most of the intestines are removed at this time. The animal is then strung up and quartered. At the same time, the retailer and a helper are going through the intestines and frontal cavity to remove the heart, liver, tripe, etcetera. The front quarters often drag on the floor even when hanging on hooks.

The animal is hacked into pieces with machete and axe. Two types of meat are classified here: meat without bones and meat with bones. Only the hind quarters retain any recognizable shape. The meat is then thrown into the back of a truck and taken to the meat store. In the meantime, another animal is killed, a little water splashed to spread the blood, etcetera, and the operation is repeated. The work is done with a fair amount of efficiency and dispatch. But people walk in and out, dogs hang around the periphery and successfully nab stray pieces of meat, and one morning two vultures made a successful raid.

Each retailer returns later to pick up the rest of the animal; head, feet, remaining intestines, and hide which have been piled on the floor. These are cleaned to a certain extent and also taken to the shop.

Colonia Carranza has a slaughter house on the more primitive variety. A small wooden shack with open walls and a cement floor, this building's facilities consist of one tap for running water and nails hammered into two by fours on which meat is hung. The animal is killed with a knife and the whole operation of skinning and cutting up the carcass takes place on the floor. The meat is hacked up into relatively large pieces and then carried by hand to the meat shop. In field slaughter, the hide itself serves as the base on which to put cut meat. A nearby stream serves to wash the meat after it is cut.

There is a clear division of labor to be found in this particular aspect of the beef cattle industry. Specialists slaughter and butcher animals, the retailer never does this particular job. The retailer invariably has at least one helper to assist him in carrying the meat to the shop. In many cases this helper actually runs the shop and cuts the meat as desired by the customer. By law, a veterinarian is supposed to inspect the viscera after slaughter to ensure that no communicable diseases are present. In actual fact, inspection can be a hit or miss thing, not because of the low cost (£3 per animal), but because the veterinarian is often 'unavailable'. All labor costs average £35 per animal not including the retailer's own labor.

The retailer has other costs. The permission for slaughter which he needs to buy from the local fiscal office costs £9. Very few have refrigeration, but some have small electric saws to cut the bones and all have some electricity. This costs approximately £2 per animal. Most do not have these saws and depend upon knives, machetes, and axes to further cut and shape meat. Brown paper or the new innovation of cellophane in which to wrap the meat after sale costs around ₡5 per animal. All have rental costs, but these vary with location. In Las Juntas, for example, the renting of a stall in the market costs ₡15 per month. In Liberia, on the other hand, prime location in the central market can cost as much as ₡120 per month. Most retailers have locations outside the central market in their own building and costs can be relatively low. Finally, there is the cost of traveling to buy an animal and the cost of bringing it back to town. All in all costs average between ₡65 and ₡75 per animal. When one adds the initial ₡450 to ₡500 price of the animal, the mayorists has a substantial investment.

No meat retailer has a good idea of how much of each class of meat is sold per day. Customers enter the shop, ask for a particular class of commodity, and the butcher cuts this from a segment of meat, selling it on a cash basis. When one piece of meat is gone, the butcher starts on another. Usually by ten o'clock only remnants remain. All meat is sold in pounds so all scales are American made and graduated in pounds.

One meat retailer in Nicoya had the following idea of the quantity of meat derived from each animal and others did not vary too greatly from these figures in their estimates. He sold one quintal (one hundred pounds) of meat for ₡3.00 per pound, one quintal of meat and bones for ₡1.00 per pound, thirty pounds of hamburger, which he made on his own grinding machine from scraps, for ₡2.50 per pound, and twenty pounds of high grade meat worth ₡4.00 per pound. In addition he obtained approximately ₡50 for the heart, liver, brains, tripe, etcetera. The hide is worth up to ₡20 for a good one, but because many hides worthless, an average of ₡10 is given. The hides are sold to local merchants who make saddles, bridles, etcetera, or are sold to middlemen who take them to Puntarenas or San Jose where there are leatherworks. Thus, the mayorista sells approximately ₡615 worth of meat. As he is buying the animal live, mistakes can be made and a net loss could be suffered. Rarely do profits exceed ₡100; an average profit of approximately ₡60 per animal is made. This makes him one of the poorer retailers in the service industries in Guanacaste.

Two further points need to be made. Prices to the consumer tend to be lower in smaller towns, but costs do not vary. Thus mayoristas in smaller towns make less money per animal. Second, in the larger towns where four or five butchers are able to make a living, a demand may not equal the meat produced by four or five animals. In these cases, butchers often cooperate by buying an animal together and retailing only half each. It is much better for them to undersupply rather than to oversupply, and a mayorista cannot close because he has regular customers who come every day.

Thus far, the discussion has centered around middlemen who buy and sell within Guanacaste. The vast majority of animals, however, flow into the Meseta Central areas where over two-thirds of the population live.[7] Three principal channels conduct animals from Guanacaste to the Meseta Central: the comerciantes, engordaderos, and the criadores themselves.

Comerciantes

It is the comerciantes who buy from the minorista grande and ranch Sizes B, C and even D. Their trading area is simplicity itself, they deal only along roads and in towns. As mentioned before, the smaller middlemen and comisionistas have collected cattle into several well-known points by the end of the week. The comerciante usually lives in one of the canton capitals and does most of his buying in that town. But he faces competition from other comerciantes also living there, and some comerciantes come all the way from the Meseta Central. Another central place tendency exists, as the canton capital gets larger, more comerciantes are present. Most travel to neighboring capitals at least once to get a feel for market prices and an indication as to whether supply is too great or inadequate for the Meseta Central market. While there they will bargain, sometimes to such an extent that they do not buy at all in their own town that particular week.

Friday evening and Saturday are the buying days for cattle going directly to market in Guanacaste, as Sunday is the market day at the Plaza de Montecillos, the principal market in the Meseta Central. The comerciante buys mainly Output IV, as he cannot compete with the engordadero for Outputs I and II. As the engordadero does not usually want Output IV, these two types of middlemen can live in harmony.

The comerciante's principal function is to organize the transportation of animals from Guanacaste to the Meseta Central and to find a buyer there. The comerciante may have his own truck or fleet of trucks or he may rent a truck from one of the numerous trucking firms which exist in Guanacaste. The small comerciante, driving his own truck, may handle fewer animals than a minorista. This size of operation may exist in a town such as Arenal, Bagaces or Colonia Carmona, and the comerciante in this case usually has some other occupation as well. The large comerciantes operating out of Liberia, Cañas or Nicoya can buy and sell up to a hundred animals per week. Actual total numbers of animals flowing out of Guanacaste for the national market which are handled by comerciantes can range from over a thousand to under three hundred head per week.

The price at Montecillos on Sunday sets the average price a comerciante is willing to pay for animals, but the number of contacts the comerciante has outside the Plaza determines the degree of competitiveness among these middlemen. The Plaza provides the slaughter facilities for retailers in San José, Alajuela, Heredia and a few other large urban areas. But most Meseta Central municipalities have their own slaughter houses where animals are killed every day. If a comerciante has good contacts with retailers in these municipalities, he can buy and sell all week long and build up a tremendous volume of animals. In these cases, a comerciante will take profits as low as ¢10 per animal. A comisionista will alter his buying patterns under these conditions. While on weekends he usually buys all animals at one or two locations from minoristas or comisionistas, during the week he buys from Size B, C, or D ranchers anywhere these ranches have truck accessibility. He often makes arrangements to see animals at locations off roads if they are not more than five kilometers away or he will meet the rancher at one of the loading corrals along roads. The rancher has to meet him at a specified time and place with an extra horse in the first instance. The rancher is usually in a little poorer bargaining position as only one comerciante sees the animals. The only condition the comerciante makes is that the rancher sell fairly large lots of animals under these arrangements.

Other comerciantes who own trucks develop contacts in other sectors of the economy. If they have contracts to haul supplies from the Meseta Central to Guanacaste, they can again afford to take less profits on their cattle marketing. Largeness means proliferation on these contacts. A small comerciante who has to deadhead back from Montecillos and who buys only on weekends has to be an extremely able judge of animal quality and weight to stay in business. In fact, there is a trend toward largeness in Guanacaste, and a trend toward localizing the market function into a few high-order central place towns.

The market in Montecillos and the expenses of transportation affect the operating costs of the comerciante, and are of sufficient importance to be analyzed individually. One cost can be given now. The marketing process at Montecillos takes sufficient time on Saturday and Sunday so that the comerciantes have the ordinary travelers' costs of meals, bed, etcetera, which average around ₡40 per trip.

Engordaderos

The engordadero, as a type of middleman, also makes his final sale to a processor. It was noted previously however, that engordaderos often sell to other engordaderos. Thus, as a class, they exhibit both provincial and national marketing patterns. For the present, animals destined for the export market will not be discussed, but are treated in a separate section later

As mentioned before, the buying habits of the engordaderos varies with ranch size. It is very difficult to classify these ranches when it comes to marketing patterns. A basic, two fold division of small versus large (or ranch size C versus D) is followed, but there is a great deal of overlap This overlap is not caused by characteristics intrinsic in the ranch itself but in what other occupations the owner has If the rancher derives a substantial proportion of his wealth from some non-agricultural occupation, then characteristics of a large engordadero ranch can be superimposed on a relatively small operation.

The small engordadero is in many cases surrounded by large numbers of criador ranches. His locational distribution has a pattern of points scattered throughout the Nicoya Peninsula, along streams or roads, and along roads in Region III. In most cases, the small engordadero has been absorbed by large operations in Region IV. The locational situation with regard to criadores and minoristas means that the animals which people want to sell are brought to the engordadero's ranch for his approval. The engordadero buys or rejects animals on their individual merits, thus buying from one to twenty animals at a time.

He very rarely buys Output IV because they do not gain weight as fast as males. If he does buy, it is only because he is understocked, and he keeps the cow for a maximum of one or two months. He is most interested in buying young calves which have just been weaned (Output I) or novillos (Output II) which still have a considerable potential for growth. He usually cannot afford to buy novillos which he could sell directly to the Plaza de Montecillos after a few months fattening.

The small engordadero invariably sells to a large engordadero who completes the final fattening. A standard truckload of fifteen animals is sold each time. The animals are either sold as a lot, or sold individually on their own merits.

The large engordadero is the most widely traveled man in Guanacaste. The whole of Guanacaste and even substantial parts of Puntarenas are his territory. His location is determined primarily by climate (Region IV) or the possession of extensive bajuras (the lower Río Tempisque), but he is fortunate in that his location is central to his trading area. Those along the Río Tempisque do not seem to have the advantage, as poorer roads to their ranches balance the slightly greater distances the engordadero in Region IV has to travel over excellent roads.

The engordadero travels the main paved roads for the most part, but will make trips on all-weather roads to places like Jicaral and Portegolpe. They participate in the weekend sale of animals in towns, but they are very selective in their buying. They are interested only in Output II, and prefer, whenever possible, an animal with visible Brahman blood. They rarely buy purebred criollo novillos, these gain weight very slowly and consequently they often do not go through the fattening process at all. Engordaderos buy from other engordaderos, from comisionistas and minoristas grandes, and from Size C and D criador ranches. Many large criador ranches sell novillos as the dry season approaches; such a transaction may involve hundreds of animals at one time. The large engordadero will buy from smaller ranchers if they are neighbors and if they produce good quality stock.

The reason a large engordadero buys in large lots is because he is under a great deal of time pressure. His own animals are sold on the export and national market from July to December so he needs animals to utilize his pastures. But this is the time when most criadores have excess pasture and they prefer either to let their novillos grow in weight and value or sell for high prices. In November and December, criadores are willing and need to sell for lower prices. The engordadero thus might concentrate his entire yearly buying within two or three months. He needs to buy animals, finish selling old ones, organize transportation, get the new animals started on the right pasture rotation, and so on. He simply cannot take time to stop and buy one or two animals at a time.

Because the engordadero has both ranch and market functions, his profits per animal will be computed on the basis of the cost-benefit formula being developed.

Criadores

Only the large Size C and D ranchers participate directly in the market in the Meseta Central, and even many of these find it unprofitable. In some cases they will notify a comisionista at Montecillos to sell their animals for them or they will intrust the truck driver or a comerciante to bargain for the best price. Very few own trucks, preferring to hire a common carrier for transportation.

When they do travel to Montecillos, they hire two or three trucks and go with thirty to fifty animals. Infertile cows, old bulls, and novillos all go together although they may be sold separately. If the rancher does not have sufficient animals to fill up trucks, he will often buy animals. A few criadores assume all the responsibilities and functions of comerciantes on these occasions, and may buy several truckloads. The buying territory is invariably within the immediate neighborhood.

Summary of Marketing Channels

The marketing channels discussed above range from simple to complex. A complex channel in terms of middlemen is one in which an animal goes from minorista pequeño to minorista grande, to comisionista or small engordadero, to large engordadero or comerciante, to the processor or retailer. This channel can be lengthened considerably as the animal may pass through the hands of four or five [illegible] and three or four engordaderos. In one specific example animals changed hands ten times from birth to slaughter.

On the other hand, any one or all middlemen might be eliminated from the marketing process. A mayorista, for example, sometimes raises and slaughters his own animals and then sells the meat directly to consumers. The most common channel in terms of numbers is from criador to engordadera, to markets in the Meseta Central. Thereafter, it is impossible to determine what combination of middlemen handles the greatest quantity of animals. There are no set rules, no pattern, and no predictability as to how animals go from rancher to consumer.

Isolation, ranch size, output factors, etcetera, all combine in a variety of ways, and this permutation means that, within Guanacaste all types of middlemen are essential.

Transportation

An analysis of the following map shows that most settled parts of Guanacaste can be serviced by trucks for at least part of the year.[8] Until quite recent times, Guanacaste's transportation network was a system of trails only. Around the year 1840, a right of way from the Meseta Central to Nicaragua was established.[9] Thirty varas wide, this became the principal road for trail drives moving cattle from Guanacaste to markets in the urban areas of the country. Several feeder trails connected with this one. The most famous one was a trail from the Nicoya Peninsula across a ford on the lower Tempisque and connecting to the 'Camino al Guanacaste' near Palma

Very early, limited amounts of cattle went by launch from areas on the Nicoya Peninsula to Puntarenas. With the advent of the Pacific Railroad,animals were loaded on boxcars and taken to San José This traffic became so important that a second national trail was established from Puerto Jesus through Nicoya and ending in Santa Cruz. From 1936 to 1944 twenty kilometers of this road were asphalted, something that one would never believe when driving that road today. Over the span of a century the river estuary connecting Puerto Jesus to the Gulf of Nicoya silted up and all water traffic has ceased except for a few small fishing boats

As early as the 1920's the possibility of land cargo was recognized as being more practical for Guanacaste. The Camino al Guanacaste was widened and improved, and under the presidency of Jimenez a bridge over the Rió Tempisque allowed continuous land transportation from Liberia to Nicoya

It was not until World War II and the building of the present-day Pan-American highway that significant truck movement of cattle occurred Before that commodities and people would be transported by vehicle; cattle continued to walk. During the 1940's and 1950's feeder trails were converted to carry truck traffic.[10] This last decade was the next era of significant road building. Paved roads to Tilarán and Las Juntas are very modern and new, except for a few narrow, one-lane bridges.

Main construction occurred southward from Liberia. The excellent Highway 21 extends from Liberia to Nicoya Built in three sections in three years, from Liberia to Filadelfia, Filadelfia to

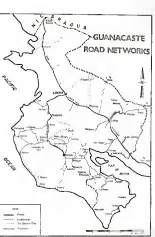

GUANACASTE
ROAD NETWORKS
NICARAGUA
PACIFIC
OCEAN
GULF OF NICOYA
N
Peñas Blancas
La Cruz
Liberia
Bagaces
Tilarán
Cañas
Filadelfia
Belén
Santa Cruz
Santa Bárbara
Carrillo
San Antonio
Nicoya
Las Juntas
San Joaquín
Puerto Jesús
Mansión
Hojancha
Colonia Carmona
Nosara
Samara
Lepanto
Jicaral
Paquera
Tambor
Cóbano
KEY
Paved
All-Weather
Dry Season Only
Projected

Figure 12

Santa Cruz, and Santa Cruz to Nicoya, it was just completed in 1968 Major improvement of the road from Nicoya to Colonia Carmona and Jicaral has also just been completed The same program saw the first circuit connecting towns like Portegolpe and Paraiso to existing facilities. The bridges, always the last to be constructed, were in place by the end of 1969. A few other all-weather roads were also completed under this massive road building program [11]

Emphasis seems to be shifting away from road building to a certain extent however. The impetus will probably be sufficient to finish the road to Lepanto, but the future of the Jicaral-La Presa and the Tauber-Cóbano roads is a little more doubtful [12] Three other significant road building plans are at present in the talking stage, but nothing concrete has been determined as yet An idea for a circuit road connecting such towns as Jicaral, Paquera, Cóbano, Manzanillo, and Canjel would remove the factor of isolation from the last major population centers of the Nicoya Peninsula. An all-weather road from Paraiso to Manzanillo and another from Caimital to Sámara would give the peninsula a good circuitous network.

The other two plans would have great significance for the beef cattle industry The construction of all-weather roads to Upala and Fortuna could radically change the nature of the industry and lead to regional specialization on a national scale. These roads would open up areas on the Atlantic coastal plain where there is no dry season. The weight losses which cattle suffer due to the dry season have been well documented earlier, even under a situation of regional specialization within Guanacaste These roads are conducive to the evolution of a system where only breeding herds are found in Guanacaste and only fattening herds are found in the Atlantic lowlands. It takes two and one-half to three years to produce a marketable animal in Guanacaste under the best of conditions. If calves, immediately after weaning, were transported across the Guanacaste Cordillera, this animal could reach the market in two years. As mentioned before, this regional specialization is occurring to a certain extent already as ranchers in Guanacaste buy land in the Atlantic area.

The road to Upala seems to be one of those perennial projects which never gets started.[13] At present it is passable by truck once every four or five years. The Arenal-Fortuna road is passable by jeep most dry seasons. Firm plans were made in 1968 to convert this into an all weather road but disaster struck. Volcan Arenal, near Fortuna, erupted causing great loss of life and property. After a series of eruptions, the volcano spewed forth great quantities of magma. Lava flows covered the old dry season road by mid-1969, and all planning has stopped until the situation stabilizes. Eventually a road will link the two major cattle regions of Costa Rica and tremendous benefits will occur.

The all-weather road network as it is at present has accomplished a major objective of the Ministerio de Transportes. Except for the southern tip of the Nicoya Peninsula, all cattlemen can trail drive their animals to facilities for trucks in one day. Animals from areas near the Guanacaste Cordillera are driven a very long day to reach truck facilities, as do those from parts of the Nicoya Peninsula. Ranchers who can drive their cattle to market and return the same day are in a very advantageous position when compared to more isolated ranchers. A different kind of agricultural activity would, of course, require a much denser road network to serve the majority of the population

The penetration of good roads southward into the Nicoya Peninsula has completely altered the flow patterns of cattle for that part of Guanacaste. Before the presence of roads, most cattle along the coast from Jicaral to Garza were transported by water to Puntarenas. Now almost all cattle are driven to points such as Jicaral, Canjel, Hojancha, Paraiso and Nicoya and loaded onto trucks to go to market via Liberia. This is done in spite of the fact that the cost of water transportation per animal is cheaper and weight loss actually might be less. The reason for this shift is found in the lack of facilities; in many places where loading was accomplished, it was done using a hoist. At Puntarenas, the difference between boat and dock level was sometimes several feet. As a consequence, the animals suffered extreme abrasions, bruises, and even a 2-3% mortality rate.

A complete feasibility study was done in 1960 on the possibility of building adequate dock facilities near Lepanto and initiating regular ferry service which would eventually be capable of carrying trucks.[14] The conclusions of the report were highly favorable, but this seems to be another one of those plans which never gets off the ground. If completed, traffic over much of the Nicoya Peninsula would again flow south. Considering the excellent Highway 21 and the high speeds which truckers are able to drive, the reduction in weight losses for animals north of Nicoya would be insignificant. For animals derived from more southern parts of the peninsula, however, reduction in weight losses would at least pay for variable costs and a doubling of fees would be possible to pay off fixed costs on the investment. For the few animals still being shipped, fees are approximately ₡20 for the sixteen kilometer journey to Puntarenas from the planned port area

Costs of transportation naturally show some correlation with distance. Many of the dry-season roads open for truck traffic from January to April. Some ranchers try not to sell until then rather than trail-driving. From the southern Nicoya Peninsula, transportation costs are ₡55 per animal. From Jicaral the cost is ₡50 per head; from Nicoya and Santa Cruz and Peñas Blancas, ₡40; from Liberia, ₡30, and from near the Puntarenas border, ₡25.[15]

Trucking is a highly competitive business in Guanacaste with many small firms operating out of large towns. The average trucking firm consists of two trucks, but the majority have only one. A few firms have several trucks each and have been able to introduce large capacity trucks to haul live cattle. The average truck, however, has a capacity of fifteen novillos or twenty cows.

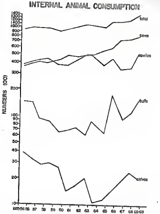
The trucker is responsible for any mortality or accidents which occur on the truck, so he is very careful. The truck is provided with cleats to give the animals a firm footing, on poor roads speed is very slow, and there is often a boy riding on top of the truck to make sure no animal falls. The trucker is not responsible for weight losses however. Weight losses are very high for those animals going to the Plaza de Montecillos.[16] Very few exact figures can be given as few ranchers have scales to obtain initial weight. One rancher had exact loss figures from Liberia to Puntarenas, these ranged from 5.6-7.3% and this would indicate a weight loss of 10% to Montecillos. Another rancher (actually in Puntarenas) had weight losses of 8% to Montecillos. Retailers from San José discount an animal's weight by 8% when making a purchase in Guanacaste.

Weight losses can be blamed on both general marketing practices and transportation. Animals are often kept without food, and sometimes without water, from Friday night when they are in holding corrals or poor pastures in Guanacaste until sometime after they are weighed at Montecillos Sunday morning. Transportation is responsible for a conservative 8% weight loss. While Highway 21 and the Pan-American highway are conducive to high speed traffic in Guanacaste, the Pan-American highway from Cañas south is in a state of deterioration. In many segments the pavement has disappeared altogether or is so full of potholes as to be practically impassable. This lengthens the time needed to truck cattle to market by several hundred percent over optimum conditions. Besides this the trucks sway and roll even under very low speeds, the cattle shift back and forth and bruising and abrasions occur. Within the Meseta Central area itself the Pan-American highway is excessively curved, and the cattle continue to suffer. Both situations are being corrected at present. Contracts were let in 1969 for the complete resurfacing and some straightening of the Pan-American highway. In addition construction has been in progress to build a new highway without many curves or steep grades which will bypass the worst section of the Pan-American highway in the Meseta Central area.[17]

National Market

The characteristics of the national market will not be examined in detail in this study but there are certain trends which affect the beef cattle industry of Guanacaste and these will be presented. There was never any question that Costa Rica's main slaughter house would be located in the Meseta Central.[18] Animals must be slaughtered every night and the meat sold the next day to comply with health regulations. It was only in 1959 that Montecillos itself got refrigeration, and there are no refrigerated transportation facilities which could haul carcasses from slaughter houses outside the Meseta Central to serve the domestic market. When another major slaughter house needs to be built, and when other producing areas can keep the Plaza de Montecillos' operation at capacity, then serious consideration could be given to a new slaughter house in Guanacaste. Improved roads and refrigerated trucks would make this an economic proposition.

Internal consumption in terms of total animals slaughtered has shown a slow steady increase to 136,346 animals for the period 1968-1969 as is shown by the following figure. In terms of percentage, cows increased from 41% of the total in the cattle year 1955-1956 to a high of 61% for 1966-1967, and has since dropped to 55% for the year 1968-1969.[19] In terms of absolute figures,



Source: CNF, Unpublished material

Figure 13

extraction has been slightly higher than increase in total herd size. There is one type of animal which was combined with the figures for bulls. These are bueyes, or those ubiquitous draft animals of the Meseta Central. Ten to fifteen of these are sold every week. Bulls fluctuate between 6% and 15%, but has shown some decrease in recent years. The number of novillos in the internal market is, to a high degree, dependent upon the success in the export sector. Novillos as a percentage of total animals slaughtered range from 29% to 52% for the period 1955-1956 to 1968-1969.

It was estimated that from December 1, 1968, to November 30, 1969, a total of 52,000 head of cattle would be slaughtered for internal consumption at the Plaza de Montecillos.[20] They predicted a slaughter of 10,000 animals destined for the export market as well. Because of this large number of animals handled, Montecillos determines the price for the whole country.

The marketing operation on Sunday is accompanied by continuous bedlam. The animals have all arrived Friday night or Saturday. Buyers wander up and down making various bids to different owners, with the owner listening to several buyers before making a final deal. Comisionistas work here as well, taking a 2% finders fee to bring buyers and sellers into agreement. A good comisionista will feel the pulse of the market fairly quickly and will usually earn his money by obtaining a high price for the rancher. It is usually ranchers who hire these people, as all middlemen are well acquainted with everyone. Process is slow at first, but when a deal is concluded animals are driven from corrals on one side of the market building, run and prodded with steel tipped poles o to a large scale. A few buyers have traditionally held certain corrals, the name of the buyer is shouted out after weighing and the animal(s) herded into his corrals on the other side of the building. The seller is paid so much a kilogram immediately after weighing. As the morning wears on, the pace picks up and a note of urgency creeps into the whole operation. Animals are run from place to place, horns get broken off, and once in a while a leg is also broken. At least a 2% weight loss occurs By early afternoon, the animals have been loaded and taken to holding pastures to await their day of execution or are taken for further fattening.

The seller usually has to pay costs of handling and storing animals within the corral area. This is a fixed fee of L3 for the animal and L2 for the animal handlers. The fee for the scale can be paid by either buyer or seller.

Ranchers own a substantial porportion of the slaughter house facilities. These buildings are set off from the selling plaza Stockholders of the slaughter house can ship their animals to separate unloading facilities any time of the week. The hectic pace of the main plaza is avoided, and thus weight losses are minimized. These large ranchers often have an arrangement with a retailer to sell a specified number of high-quality animals for a fixed price every week.

There are interesting annual fluctuations in terms of numbers of animals entering the plaza of Montecillos.[21] From July through

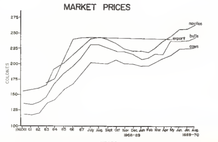
October, relatively few novillos, approximately 140 per week, are sold. As each novillo on the large engordadora or criador ranches becomes ready for market, he is designated for the export market rather than for national consumption. By November however, many ranchers have filled their export quotas and have to sell internally, Or they see that they have more animals than are required for the export market quota, and start selling to both markets. From November through to March, there are consistently over 200 novillos each week at Montecillos. During April, engordadora ranchers in Region IV abandon hope that the export market quota will be increased and sell off all their animals not needed to fill their quota. In one week in April, 1968, over 600 novillos were sold for internal consumption. May and June again average over 200 novillos a week. Bulls do not show this seasonal fluctuation.

The pattern is different for cows. The heavy sell-off months are October, November, and December when an average of 570 cows per week flow through Montecillos. These are the months when ranchers cull their herds to prepare for the dry season. There is a stable flow of cows out of other regions as they cull year round, this does have a stabilizing effect on quantity fluctuation. Even so, there is a great fluctuation week by week during the other nine months of the year. In two weeks in July, 1968, for example, the total numbers of cows sold were 392 and 693.

During 1968 to 1969 the average weight and price for cows were 375 kilograms and ₡750 respectively.[22] For novillos the figures were 425 kilograms and ₡975 and for bulls the averages were 525 kilograms and ₡1,180. The following figure shows that both cows and novilles have increased in value between the years 1960-1961 and 1969-1970. Prices reflect the pattern of inflow of animals. Thus prices tend to be high in July, August, and September. As sale of animals increases, prices drop.

The important pattern is the relationship between the internal prices of novilles and the export price. With very rare exceptions prices are always higher for export novilles than for animals destined for the national market. This is why a quota is so important to a rancher if he produces Output III. It has only been since 1968 that some retailers are willing to pay higher than export prices to ensure that they will have high quality beef for restaurants and supermarkets.

One final point has to be made before the marketing system for export is discussed. This is the matter of national consumer trends. One study has shown that there is an elasticity of 0.883 in the demand for beef as prices go up in Costa Rica.[23] In November of 1968, the price of meat and bone beef in San José increased 2.3%, and in December 1.10%.[24] While there is seasonality in price levels, an index was established in 1964 of 100. In December, 1968, first class beef had an index of 142.8 and meat and bone beef had an index of 120.8.[25] Beef's competitors, using the same index and dates, showed that chicken was 93.3, fish 105.6, and premium pork 137.8 and that they did not increase as much in price. Another report states that in 1955-1957 the average beef consumption per year was 21.4 kilograms of carcass.[26] This was the highest



Source: Cooperative Matadero Nacional de Montecillos, Unpublished figures.

Figure 14

consumption rate in Central America, comparing favorably to consumption rates of 15.4 kilograms per capita in Panamá and 6.5 kilograms in Honduras. A steady drop has become apparent in consumption, as in 1966 only 14.6 kilograms per capita per year were consumed. Consumption in four other Central American countries dropped, Honduras to 4.7 kilograms, but Panamá was able to increase per capita consumption to 17.0 kilograms.

The principal function of the CNP is to organize the export market in such a way that there is adequate meat for internal consumption. The pressures applied against this policy by ranchers are tremendous as they want thehigher prices, but as far this is still fixed government policy. The CNP is unwilling, or unable, to reverse this downward trend in consumption however. Their basic formula is to take the consumption figures of the year before multiply by the estimated population, and predict beef demands. This does lead to greater increases in the number needed, but at the same time, primarily because beef is in a bad competitive position, the downward trend is even accelerated. To reverse this situation, the CNP needs to predict an increase in consumption every year. In the year 1964-1965, the CNP estimated internal per capita consumption to be sixteen kilograms.[27] Recognizing this downward trend, the CNP established a desirable per capita consumption at 18.2 kilograms which is still applicable for the year 1968-1969. However, within this 18.2 is to be found all the industrialized subproducts such as bonemeal. The CNP also assumed that not all the export quota would be processed for export, but would be available for internal consumption. In actual fact, the processed animals exceeded the quota in 1968-1969 as several special dispensations were given to the export sector. In addition, there is a significant, illegal slaughter of animals for the export market. These are sold directly to the processing plant or through the Plaza de Montecillos, receive export prices, and are lost to internal consumption. The CNP is again unwilling, or unable, to stop this type of operation as long as it is kept within reasonable limits.

Finally, the CNP makes the assumption that the carcass weight plus some visera would be 60.21% for novillos, 60.85% for bulls, 56.8% for cows, and 53% for calves.[28] Spread over the 136,346 animals designated for internal consumption, a 3% high estimate for all these animals means a great amount of meat which was planned for internal consumption really did not exist at all.[29]

The downward spiral of per capita consumption may have been curtailed and the situation stabilized by these measures and a growing realization that estimates of demand have to become more sophisticated. But further adjustments need to be made if the basic objective of adequate supplies of beef for all Costa Ricans is to be met. If a greater proportion of animals were to be assigned for the national market, prices would eventually be driven down. Beef consumption would become the habit of poorer and poorer people. This would ensure, in the long run, a stable and expanding market within the country. At present the reverse situation is true, a greater and greater proportion of the population is turning to other meat supplies as the price of beef is increasing at a faster rate than their incomes.

The Export Market

Laws number 1754 passed on June 15, 1954, and number 3465 of December 7, 1964, affirms that the CNP has sole responsibility for directing the export market. During 1969 there was considerable agitation that, if a nation wide association be formed, that this organization would be able to participate directly in the export market. No report can be given on this situation, but as the CNP would have ultimate control on the number of animals exported it would not be a significant change.

There is only a very small percentage of cattlemen who participate in the export market. All large engordadores have an export quota. Some Size C and D criador ranches also have quotas, but many of them do not. It is the responsibility of each rancher who wishes to participate in the export market to file a declaration of the number of animals he estimates he will have ready for market during the coming year. Only males can be declared, and this procedure must be completed by mid-June. Only 851 declarations were submitted for the year 1968-1969, but some ranchers have several quotas under names of sons, uncles, etcetera,as well as himself. If the ranch is in two or more locations, the rancher can receive a quota for each.

There is a common subterfuge which circumvents the reason for the declaration. Many ranchers will 'borrow' large numbers of novillas and bulls from ranchers who do not have a quota. Some of these animals may be developed for the market on the ranch in question, but many will not. The CNP comes to every ranch and brands the animals declared for market, but later one can see these brands on ranches which do not have a quota. This practice has become one of the principal disruptive elements in the cattle industry. Ranchers who abide by the rules demand action to stop this practice. Smaller ranchers demand that they too should be able to enter the export market, and ask for help to do this.

The reason for this is simple. The quota for export is a specified percentage of the total number of animals declared. The total number of animals for the year 1968-1969 was 155,445 of which Guanacaste had 68.55%[30] The following map shows the distribution by canton within Guanacaste. The predominance of engordaderos in Region IV, within Tilarán and Abangares, is clearly shown. On the other hand, Bagaces participates only to a limited extent because much of the land is very poor and because large ranchers in Region IA contribute very little to the export market in relation to their land holdings. In relation to its size, Nicoya also contributes less than one would expect. Animals produced here are sold to engordaderos in Region IV, and parts of the canton are uninhabited because of poor terrain.

The quota was originally set at 50,000 head or 33.3% of the number declared. The eruption of Arenal was an emergency which the ranchers were quick to take advantage of. Some ash did cross over into Guanacaste and for a few days it was thought that large areas of pasture would be destroyed. The ranchers put immediate pressure on the CNP to allow animals to be marketed in large number from these areas. The meat processing firms and the CNP were in full agreement and the Tilarán-Abangares areas had a rapid outflow of animals

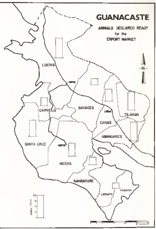

GUANACASTE
ANIMALS DECLARED READY
for the
EXPORT MARKET
N
LIBERIA
LIBERIA
BAGACES
CAÑAS
CARRILLO
TILARAN
CANAS
ABANGARES
SANTA CRUZ
NICOYA
NICOYA
NANDAYURE
LEPANTO
PAQUERA
20

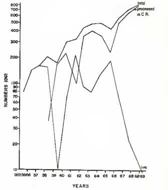
Figure 15

The emergency did not affect production however, as Arenal stopped spewing ash and rains washed away what little ash there was. Ranchers in other parts of Guanacaste demanded that they be able to market equal proportions. By the end of the year, over 70,000 animals had been slaughtered for export.

Figure 15 shows that there has been a substantial increase in the numbers of animals destined for export since the market was opened. Of even greater significance is the increase in internal processing. Only 260 animals were exported live, to the Netherlands Antilles, in the year 1968-1969. Construction of the first processing plant was completed in 1957 at Barranca, and has since been expanded to handle 250 animals a day. There are three small plants in the Meseta Central area capable of handling 10,000 animals a year. A new plant at Colorado, just outside of Liberia, has a capacity of 300 head a day.

Each plant submits a bid to the CNP stating the price it is willing to pay for animals and the amounts it will require for the cattle year. The associations of cattlemen, the largest being the Camara de Ganaderos de Guanacaste (CGG), in association with the CNP, determine if the price is acceptable and which association should sell to each particular plant. The CGG is large enough to sell to all plants, smaller associations in other parts of Costa Rica usually sell to the Meseta Central areas. Theoretically the price offered should be competitive but in actual fact all plants submitted the same bid of ¢2.35 per kilogram for the year 1968-1969.

ANIMALS IN EXPORT MARKET



Source, CMP, Unpublished material.

Figure 16

The cattlemen's associations organize the sale of animals for their members. If a rancher does not belong to an association, then the CNP will provide this service for him. There is a movement towards cattlemen's associations based on cantons. The canton of Abangares has its own association, and in 1969 the people in Nandayure and Carrillo were also organizing. The main objective is to better meet the needs of the individual rancher and to incorporate many more smaller ranchers who would like to participate. Other services such as loading corrals and chutes and the sale of ranch supplies at wholesale prices are anticipated.

In 1968–1969 no animals from outside Guanacaste were sold to the plant at Colorado. The CGG organized the flow of animals in such a way that animals in danger of being subjected to the dry season are all sold by December. This is why they have contracts with all plants, so that the oversupply of animals can be slaughtered during the first half of the cattle year. See Figure 16. Animals from Tilarán and Abangares are sold in two periods. There are some animals left over from the year before and these are sold to Colorado in July and August. Thereafter, sales decrease until late December and January when almost all the animals coming into Colorado are from these two cantones. As the CGG has substantial contracts toward the south, the cantones of Cañas, Abangares, and Tilarán are given first preference when these quotas need to be filled, if there is not a conflict with the dry season requirement. Those ranchers who have adequate bajuras are often requested to wait until February to sell the bulk of his animals. The other

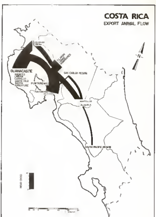

COSTA RICA
EXPORT ANIMAL FLOW
GUANACASTE
BAGACES
LIBERIA
CARRILLO
SANTA CRUZ
NICOYA
NANDAYURE
PUNTARENAS
TILARAN
CAÑAS
ABANGARES
SAN CARLOS REGION
ALAJUELA
SOUTH PACIFIC REGION
N
HEAD (000)

Figure 17

associations in other parts of the country also sell only small numbers until after the dry season commences in Guanacaste

The rancher notifies the CGG that he has a certain amount of animals available for sale. The CGG knows how many animals each plant needs every day, and will notify the rancher to have his animals ready a certain day Either slaughter house owned trucks or trucks arranged for by the CGG will arrive to transport the animals If the ranch is inaccessible to trucks, the rancher can drive his cattle to any large town where the CGG owns loading and corral facilities The rancher pays half the transportation cost, the plant the other half From Nicoya to Barranca, for example, the total cost is ¢30, from Nicoya to Colorado only ¢15

The rancher has a few other responsibilities The animal must be over 410 kilograms when weighed at the plant This is after at least a twelve hour food and water free period If an animal shows signs of external parasites such as the trosalo, or of poor health, it is not accepted A low rate of rejections by the plant do occur, in which case the rancher pays the full cost of transportation to and from his ranch.

The meat packing plants do not have to be analyzed in detail The year 1968-1969 was a year of shutdown and crises. The plants had difficulty opening because they could not obtain sufficient credit The banks of Costa Rica finally made loans available, and other credit was obtained from meat buyers in the United States The major problem is that while they have to pay the rancher upon delivery of animals, they do not receive returns on their investment for at least three weeks

All meat goes either to the United States or Puerto Rico and is under the health standards set by the United States Department of Agriculture. An inspection by this agency in September found that none of the plants, including Montecillos, met standards The whole meat packing industry was shut down for over a month to correct deficiencies in the physical plant, in the health standards and inspection routine, and in everyday meat handling operations A strike in December on the New York docks forced a slowdown on the plants operating in the Meseta Central

Boneless beef processed at Colatado goes by refrigerated truck to Guatemala, then by boat piggyback from Matias Galvez to Miami or Tampa. Meat processed at Barranca or in the Meseta Central also goes by refrigerated truck to Guatemala, but large amounts go by refrigerated ship from Puntarenas or Limon, and small amounts go by air from the international airport near San José Barranca and Colatado produce a full range of subproducts which are sold on the national markets. One plant in the Meseta Central makes prepared meats for the national market, and is just building the infrastructure necessary to industrialize the other waste products This is highly significant, as only 30% of the animals' weight is exported as boneless meat.

The slaughter plants have demonstrated one very vital factor: they have the capability and the organization to handle the number of animals which will be produced in the foreseeable future. These operations are primarily Costa Rican owned, and do contribute substantially to the industrialization process of development in

Costa Rica.[31] At some future point this could be a problem which needs to be resolved. The CNP, MAG, CGG, and the meat packing plants have indicated interest in obtaining markets other than in the United States, but the end of the cattle year 1968-1969 did not see these markets materialize.

The second factor of importance is that the plants can process and transport the boneless meat for around $0.07 United States a pound.[32] This again is competitive by world standards and Costa Rica's beef will not be priced out of world markets in the foreseeable future.

Summary of Cattle Benefit Basis

So far no mention has been made of the prices the ranchers actually receive for their animals. The most important determining factor is, within each output, the quality of the animal itself. It was seen in the production function that this depended a great deal on the bloodlines of the animal, the care it had received, the time it was sold with regard to the dry season, and so on. The second important determining factor is, within the national market, the choice of market channel(s) which each rancher makes either voluntarily or out of necessity.

As mentioned, the price at Montecillos averages ₡750 for cows and ₡975 for novillos. The most direct channel, direct criador sale, would have these figures depreciated by ₡50 to ₡80, cost depending upon the location within Guanacaste of the rancher concerned. Each middleman takes ₡20 to ₡30 to cover his profits and costs. Thus, for a rancher in a poor marketing position, the price he receives would be an additional ¢150 below the national market price. Increased isolation and decreased size force lower and lower prices, to a maximum of ¢230 below market prices in Montecillos. Poor quality criolla animals can be depreciated much more below this figure. Adjusting for location output, ranch size, etcetera, a benefit formula can be created. It must be emphasized that while the cost half of the formula is fairly consistent, the benefit formula would show much more variation between ranches in the same size category.

Very rough parameters can be given based on quality and market conditions. Output I is worth between ¢200 and ¢350. Output II at one year is worth ¢400 to ¢500, at two years from ¢600 to ¢700, and at three years ¢700 to ¢850. This last price means that the animal is almost ready for market. Animals sold for the export market bring approximately ¢1,000. Output III will sell for ¢2,000 for an encastado animal. Output IV ranges in value from ¢450 to ¢700. Output V, based upon output and price of milk in Guanacaste, has been given a value of ¢500 per ranch per year.

Using the mathematical models developed before in the production function, it is possible to determine the numbers of each category sold. The number of calves produced every year has already been determined. The number sold is assumed to be the number produced minus the number to be kept for internal breeding (vaquillas) and minus the numbers to be kept for Outputs II and III. The total number of Output II on each criador ranch has also been computed.

For the sake of clarity, it is assumed that one third of these animals is sold every year at three years of age. In actual fact the proportion between one, two, and three year olds, is rarely one to one to one. A rancher, blessed with a short dry season, may keep all his novilles, and sell most of them as the next dry season approaches when they are two years old. A severe dry season may force him to sell them all. He may keep only every third calf crop, selling off the other two as Output I. In terms of monetary returns, however, the above assumption is reasonably valid. Output II has been determined, the assumption here is that one-half is sold every year as unproved ready to breed bulls. Output IV also has been computed for each ranch size. The numbers sold are those replaced by three quarters of the vaquilla population, minus the mortality rate of cows and plus the number of cows brought in from outside the ranch. A further assumption is made that the herd size is stable.

The basic formula would be:

Z = A(Output I) + A(Output II) + A(Output II_1) + A(Output III) + A(Output IV) + Output V where

Z = the total inflow of money in terms of colones,

A = the number of animals sold,

Output I = value of calves,

Output II = value of novillos or bulls just about ready for market,

Output II_1 = value of novillos or bulls sold for export,

Output III = value of toretes ready for breeding,

Output IV = value of cows not to be incorporated into the breeding herd, and

Output V = value of dairy products.

Using the herd composition found in Table IV, the formulas derived for the production function, and the value of the animals at the ranch, the benefits (Z) are

Size A $Z = 3.1(200) + 0(700) + 0(1000) + 0(2000) + 0.75(500) + 500 = £1{,}500$

Size B $Z = 5.4(250) + 3(750) + 0(1000) + 0(2000) + 7.5(500) + 500 = £7{,}850$

Size C $Z = 51(300) + 16(800) + 0(1000) + 8.5(2000) + 28(600) + 500 = £62{,}400$

Size D $Z = 207(350) + 0(850) + 125(1000) + 8(2000) + 30(650) + 500 = £233{,}450$

This completes the information necessary to develop the cost-benefit formula. As one of the principal objectives of the research was to determine the degree of economic prosperity and rationality among the various ranch sizes, the actual computation of the formula will be left for the conclusions and recommendations

NOTES

1. Figures adjusted from national figures provided by the CNP.

2. This type of thinking was much more prevalent in San José than in Guanacaste. Several people working in MAG said that the greatest problem the small rancher had was the inability to sell directly to a retailer. While they recommend removing cinstristas, they will not say what facilities and marketing centers will be provided to replace them.

3. Dirección General de Estadística y Censos, Población Total de la República de Costa Rica por Provincias, Cantones y Distritos, Ministerio de Industria y Comercio, San José, 1968, p. 1.

4. _______, Unpublished documents, 1969.

5. Estimates provided by the mayoristas in Guanacaste.

6. Dirección General de Estadística y Censos, Unpublished documents, 1969.

7. _______, Población Total, 1968, p. 1.

8. The classification of roads is the author's own responsibility.

9. Ministerio de Obras Publicas, Anteproyecto Portuario, Península de Nicoya, Ministerio de Obras Publicas, San José, 1960.

10. Ministerio de Transportes, "Los Recursos de Transporte de la Península de Nicoya," Unpublished manuscript, San José, 1964.

11. _______, Unpublished material in the form of maps, charts, and brief reports, San José, 1950-1959.

12. There has been a shift away from Guanacaste to the Atlantic coastal areas in terms of national interest. In part this is due to the resurrection of the banana industry in that part of Costa Rica.

13. Ministerio de Transportes, "Justificación Económica Proyecto de Camino Cañas-Upala," Ministerio de Transportes, San José, 1968.

14. Ministerio de Obras Publicas, Anteproyecto Portuario, 1960.

15. An unpublished report gives the figure of ₡40 to transport animals from Liberia to Alajuela. This difference shows better than anything else the intense competition which exists within the trucking industry. Alfaro, C., Pérdidas de Peso en el Transporte y en Destace de Ganado de Carne, STICA, San José, 1959, p. 8.

16 The ranchers varied greatly in their assessments as to how much animals lose when going to market

17 Ministerio de Transportes, Proyecto El Coco-San Ramon, Ministerio de Transportes, San José, 1965 This project has a planned completion date of 1972

18. CNP, "Proyecto de Inversión para un Nuevo Matadero para Dar Servicio en la Meseta Central," CNP, San José, 1958 As early as 1953, land had already been purchased in Montecillos.

19. _______, "Ganado Vacuno, Información para la Fijación de la Cuota Exportable, Periodo 1968-69," CNP, San José, 1968, p. 16.

20 Cooperativa Matadero Nacional de Montecillos, "Proyecto de Presupuesto para el Ejercicio Económico, 1 de Diciembre, 1968 - 30 de Noviembre, 1969," Unpublished report, Cooperativa Matadero Nacional de Montecillos, 1969, pp. 1-2.

21 Taken from weekly lists of animals processed by the Plaza de Montecillos These are compiled by the Cooperativa Matadero Nacional de Montecillos.

22. Ibid.

23 Bernand, G., "Informe para la Fijición de las Politicas Ganaderas a Cargo de Consejo Durante el Año Ganadero 1965-66," CNP, San José, 1965

24 Dirección General de Estadística y Censos, "Indicies de Precios el por Menor Noviembre y Deciembre, 1968," Dirección General de Estadística y Censos, San José, 1969, p. 8

25 Ibid., p. 9.

26. Grupo Asesor de la FAO para la Integración Económica Centroamericana, Mercadeo del Ganado y la Carne en el Istmo Centroamericano, Unpublished manuscript, Guatemala City, 1968, p. 14

27 CNP, "Ganado Vacuno," 1968, p. 8.

28. Ibid., p. 9.

29. This estimate was taken from personal interviews with the management of the Plaza de Montecillos.

30. CNP, "Ganado Vacuno Cuota Asignada para Exportación Segun Numbero de Cabezas Declaradas por Camaras y Ganaderos Independientes," CNP, San José, 1968, p. 2.

31 Information from the United States embassy in San José.

32 This 0.07 was derived from several sources in the form of indications. No plant manager specifically stated this figure.

CONCLUSIONS

There is no doubt that the cattle industry dominates Guanacaste economically and areally. Cattle related phenomena are found in all but the most isolated areas of the province, and these latter areas are now being settled, the frontier economy is based on cattle. The history of the cattle industry has been one of slow, uncontrolled growth with no real guidance by man until the last half century. Since 1920 however, there have been some major changes which affected the production function of individual ranchers and which also caused major shifts in emphasis within the marketing system.

Jaragua grass established dominance in the pasture ecosystem because it is able to produce well even under infertile conditions. The conversion of extensive forest areas to grazing areas became possible for the first time over wide areas of Guanacaste. Most ranches still have forestlands, however, where the rancher feels that the economic return will not justify the expense of clearing, or where herd size is still small in relation to total ranch size.

For the main part, except in such areas as Region III, physiographic factors ceased to be responsible for the upper limit on cattle populations. Under present productive systems, it is the length and severity of the dry season which now determine the maximum possible production. Although there is an over abundance of pasture before the wet season ends, there is severe overgrazing before it commences once again. This causes increased mortality, decreased conception rates, and novillos, if subjected to the dry season, take at least three years to reach marketable weight

Effects of the dry season are found throughout other aspects of the cattle industry. Land values are depressed when compared to the rest of Costa Rica. The existence of bajuras or a shorter dry season increases the value of land. Extremes in land values are determined by physiography however. As accessibility decreases, land values also decrease. It must be realized that the prediction formula for land values is based on very crude data

In an effort to combat the dry season, two types of ranchers emerged with their own characteristic production and marketing systems. The criador ranches now specialize in the production of calves and sell these at a young age. Engordadero ranches have control of areas such as Region IV where the effects of the dry season are minimized. These ranchers buy and have become highly proficient in developing and fattening animals for final sale. Large ranches tend to have both functions

This regional specialization could be carried much further if there was adequate road facilities between Guanacaste and the Atlantic coastal areas. If specialization were to be carried to a logical extreme, then Guanacaste would become a criador area and the Atlantic coastal areas would be engordadero areas. Productivity of calves could probably be increased at least by half if this regional interchange were to occur.

At the present moment, cattle populations are held fairly constant on most ranches. Unable to increase numbers of animals, the ranchers have turned to increasing their quality through the introduction of Brahman breeding stock; they are rapidly upgrading their breeding herds by eliminating the criollo strain. As ranch size gets smaller, and isolation increases, the incidence of purebred Brahman animals rapidly shrinks to zero. Increasing isolation and size decrease reduce the mixture of Brahman blood in Brahman crosses, until many small herds are of criollo stock entirely.

The high demand for Brahman stock has created its own supply, several ranches have been converting within the last fifteen years to producing only purebred Brahmans. They have reached the point now where they have completed their internal expansion program and are willing to start selling large numbers of female and male breeding stock. This, coupled with the upgrading which has already taken place, should mean that discrepancies in the quality of breeding herds should begin to disappear quite rapidly.

The introduction of Jaragua grass and of Brahman animals were the first and second major changes which occurred in the cattle industry. There have been a host of new innovations within the last ten years. The grass species Pangola is probably the most controversial. It was introduced to increase the productivity of pasture areas, but did not materially increase the upper limit of carrying capacity imposed by the dry season. If Pangola is coupled with such 'lumpy' capital investments as haying equipment, then it can play an important role in increasing carrying capacity of the ranch as a whole. This is beyond the financial ability of most ranchers, however, unless they band together cooperatively.

There has been widespread distribution of medicines designed to protect the health of animals. These are found in the most isolated areas. Management practices designed to safeguard animals are also widespread and standard for ranch sizes. The birth rates do vary with ranch size. Things like pregnancy tests, vitamin shots, supplemental feeds, etcetera, are found only on the large ranches. These inexpensive measures are one of the main reasons for the high production rates to be found on large ranches, the knowledge of these practices should be spread as fast as possible.

Over all, it was found that ranchers' perception of the possibility of internal resource utilisation differed only in a small degree with ranch size and regional location. Ranchers in size categories B and C manage their land resource base to maximum utilization, as do ranchers who have flat, fertile areas. Large C and small D ranches have intensive programs in herd management. The smallest and largest ranches often have quite extensive ranching practices for both land and herds.

Perception rates for resources from outside vary greatly The high capital requirements for the introduction of haying equipment, or even breeding animals, are highly desired everywhere and by all ranch sizes But highly significant, low cost items such as Vitamin A shots are not perceived except by a small minority. Many of these 'minor' items could increase productivity a great deal and would be well within the financial capability of all ranchers In terms of increasing the social and economic well being of large segments of the population, programs to diffuse these ideas should reach areas such as Regions II and III where large numbers of small ranchers exist. To achieve rapid gains in productivity, diffusion programs should be orientated to the Size C and D ranchers of Region I. These already have the technical knowledge to put new ideas to work immediately, once they are convinced of the innovation's worth.

The reason for this proliferation of new techniques and intensification of the production frontier is found in the market situation of the cattle industry. Demand has increased greatly for several years as the beef industry has been able to establish foreign as well as domestic markets. Excessive market demand has had the effect of increased prices which ranchers receive for their output. There is a danger though, that beef is being priced out of reach of increasingly larger segments of the Costa Rican population, a situation which is inherently disasterous if expansion stops in the export market sector.

Within Guanacaste, it was found that accessibility factors, as well as others such as ranch size, did determine the position at which the rancher would enter the marketing channels. Increasing isolation meant that his output had to pass through several middlemen, each adding his profits and place utilities, consequently the prices the rancher received was less. In terms of service, all ranchers can receive the same no matter what their locational or size characteristics. They can sell on their ranch if they so desire with the middleman handling all the requirements of marketing

At any given time, if the difference from optimum to minimum price, based on the animal's quality, is taken as a scale of difficulty or the amount of money taken by middlemen's profits, then regional variations can be determined. As one moves away from the main roads and primary central places in Guanacaste, marketing becomes more difficult in terms of costs. This loss due to the inability of markets to deliver the animal to final consumer at acceptable prices can absorb all an isolated rancher's profits. The most favorable situation encountered in Guanacaste was found for the animals sold to mayaristas and to the meat packing plant at Colorado. Proximity to high ranking central places does mean optimization of marketing channels, since a wider range of middlemen exist in these places. Marketing costs near central places and for export are minimal. The engordaderos in Region IV have almost optimum conditions when selling to Barranca or the Meseta Central, having only transportation costs and weight losses, but they do have input marketing costs. Direct criador sale to Montecillos is also fairly optimal.

Ranch sizes C and D often find that if they are forced to sell because of dry season limitations, then sale to engordaderos is quick and profitable. Smaller sized ranchers have much more difficulty, even if they have excellent accessibility. The solution for these smaller ranchers is again some form of cooperation. The cattlemen's associations which are being established at canton level is a start, but smaller associations yet appear to be the only solution.

The following table consolidates the cost-benefit formula,

TABLE V

SUMMARY OF COST-BENEFIT FOR [illegible]
(In colones per year)

Operating Costs	Ranch Size			
	A	B	C	D
Pasture Maintenance (VPM)	670	3,350	19,400	69,000
Pasture Rotation (VPR)	0	0	3,000	9,000
Combatting the Dry Season (VDS)	40	215	2,460	14,300
Animal Operating Costs (VHO)	180	1,000	8,200	26,724
Increased Pasture (VIPR)	0	130	720	6,880
TOTAL OPERATING COSTS	890	4,695	33,780	125,904
TOTAL GROSS PROFITS (Z)	1,500	7,850	62,400	233,450
NET PROFIT	610	3,155	28,620	151,320

and the next determines the fixed capital investment and returns on that investment. It is seen that ranch sizes A and B do not spend very much money on their ranch operations. Most of the costs are actually their own labor, so they can either be counted as self-wages or at zero. The only other cost of any consequence is animal mortality, and this is an extremely variable item. Both size ranches can go for years without any adult mortality. The operating costs of Size C and D ranchers show that the increasing intensity of the production function can be expensive.

The benefits and the net return on capital investment for Size A and B would also be much higher if the mortality decreases. Low benefits reflect that the decreased ability of the small rancher to keep animals to slaughter age and the low conception rate within the breeding herds. These show no regional variations,

TABLE VI

FIXED CAPITAL INVESTMENTS
(In colones)

Type of Capital Investment	Ranch Size			
	A	B	C	D
Land Value (FL)	5,600	35,100	386,000	1,640,000
Pasture Establishment (FPE)	100	500	7,250	48,750
Present Herd Value (FH)	6,450	32,050	262,150	936,300
Herd Quality- Internal (FHI)	0	2,400	34,000	171,000
Herd Quality- External (FHE)	0	1,300	5,000	14,000
Mortality Losses (FHM)	325	2,000	9,750	42,950
Increased Pasture (FIPR)	0	1,100	8,800	48,400
TOTAL CAPITAL INVESTMENT	12,475	74,450	712,950	2,901,400
NET RETURN ON CAPITAL INVESTMENT (%)	4.9	4.2	4.0	5.2

but the elimination of one or two middlemen in the marketing process as a result of increasing accessibility, would increase total profits. Some ranch sizes B and C have another major factor which causes a low rate of profit inflow. This is the rapid conversion of breeding herds to higher and higher quality. Until the majority of the criollo strain is removed, the high incidence of young, unproductive stock decreases ranch productivity and profits. That the Size C rancher is further along the cycle is also seen. The

Size C rancher has intensified management programs to the point where several are very productive.

For Size D ranchers the process of upgrading has, except for some very large ranches, for the most part been completed except under normal breeding practices. These ranches can show the highest rate of return because they have become efficient units producing high quality animals. The retention of some animals until they reach export weight is another major contributing factor to their prosperity. Engordaderos, for example, make around ₡60 for every animal they buy and sell.

A rate of 5.2% indicates that ranching is a rational investment for capital in agriculture. This is especially true when one realizes that the land originally was obtained for next to nothing, self-wages are paid, and rural amenities and social prestige are obtained. Net return on investment figures also indicate that the smaller ranches still have need of major improvement and stabilization in their production function and in their marketing position.

The optimum size of ranch herd is difficult to determine, but it probably lies between 100 and 200 head of cattle. This allows intensive personal care to be taken of animals and land, using only family labor. Once the herd is primarily composed of high Brahman crosses, they will be able to sell at all market levels. Under present market conditions, the herd size would have to be increased as isolation increases if the same economic prosperity were to be maintained. To achieve this desideratum, three major programs would be indicated. First, the ranchers should have community pastures either in bajura areas improved with Para or in the

Atlantic lowlands. This would allow pressures to be lessened for their breeding herds on their own ranches, as Outputs I and II are shifted to areas where a marketable animal could be produced in two years. Or cooperation in other means of combatting the dry season, such as maximum utilization of haying equipment, could be highly beneficial. Second, the penetration of the export market would be much easier through cooperation rather than through individual action. And third, a high degree of intercommunication within the cooperating group would make it possible for the rapid dissemination of any new production innovations.

Under this type of system the net return of capital might be substantially higher than presently found for efficient ranchers. Thus a very prosperous rural population in Guanacaste would be created. However, regional variations in population densities, the physical environment, and the marketing infrastructure would have to be taken into consideration in any development program

GLOSSARY

Atlantic Lowlands: the continuously wet areas covering the eastern part of Costa Rica.

bajura: ill-drained areas of Guanacaste which are green for part of the dry season in Guanacaste

buey: draft animal used in the Meseta Central area.

canton: political division of a province

chapia: the process of cleaning pasture of unwanted vegetation

colon: the basic monetary unit of Costa Rica.

criador: a ranch involved primarily in breeding animals.

crillo: native cattle of Costa Rica

district: political division of a canton.

engordadero: a ranch involved primarily in fattening animals.

Guanacaste: A province in Costa Rica, and for the purpose of this study includes the districts of Lepanto and Paquera. Guanacaste is also the name of a very common tree to be found in that area

manzana: 0.69 hectares, or 1.73 acres.

Meseta Central: The highland, densely settled area of Costa Rica which includes such towns as San Jose, Alajuela, and Heredia.

Nicoya peninsula: The cantones of Carrillo, Santa Cruz, Nicoya, Nandajure, and the districts of Lepanto and Paquera.

novillo: steer, for the purpose of this study includes young bulls destined for slaughter.

peon: agricultural laborer.

quintal: one hundred pounds.

savanero: cowboy.

sitio: poor grass areas of little value in Guanacaste.

tope: upper limit, quota.

torete	young bull destined for breeding
vaquilla	young cow destined for breeding, from eight to twenty-four months

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BIOGRAPHICAL SKETCH

Vernon Arthur Smith was born May 23, 1942, at Mannville, Alberta, Canada. In June, 1960, he graduated from Mannville High School. In May, 1964, he received the degree of Bachelor of Arts, Honors, from the University of Alberta, Edmonton.

During the summers of 1963 and 1964, Mr. Smith worked with the Alberta Soil Survey in a researchcapacity. From September, 1964, to August, 1965, he worked with the Agricultural Rehabilitation and Development Administration in Edmonton, Alberta as an aerial photograph interpreter.

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This dissertation was prepared under the direction of the chairman of the candidate's supervisory committee and has been approved by all members of that committee. It was submitted to the Dean of the College of Arts and Sciences and to the Graduate Council, and was approved as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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